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DR. ROBERT HENRY THURSTON'S EIGHTEEN YEARS AT CORNELL[1]

By Dr. WILLIAM F. DURAND

LELAND STANFORD UNIVERSITY

To me has been allotted the pleasant task of giving you some account of the life and work of Dr. Thurston during his eighteen years as director of the Sibley College of Cornell University. To compress into a period of some twenty-five or thirty minutes' time any adequate account of the activities over a period of eighteen years of a man such as was Dr. Robert Henry Thurston will be, I am sure you will agree, quite out of the question; and I can only hope to give some account of what appear to be the more important features of this story.

The initial point in the sequence of events which led to Dr. Thurston's call to Cornell appears to have been a gradually growing conviction in the minds of the then president, Dr. Andrew D. White, and members of his board of trustees, that the Sibley College, as representing the School of Mechanic Arts of Cornell, was hardly realizing, in its condition during the middle eighties of the last century, the full measure of its potential standing in the domain of higher technical education.

This is evidenced by the appointment by the trustees, on June 18, 1884, of a special committee known as the "Committee on Revision of Sibley College." This committee comprised the president of the university, Dr. Andrew D. White, Honorable Hiram Sibley (the founder of Sibley College), the chairman of the Board of Trustees, and one graduate of the Department of Mechanic Arts to be selected by the trustees. The resolution calling for the appointment of this committee prescribed its duty as that of considering "all

[1] Address at the celebration at Cornell University of the hundredth anniversary of the birth of Robert Henry Thurston, October 25, 1939.

questions relating to the Mechanic Arts Department," and the resolution itself was accompanied by a declaration of purpose reading as follows:

Resolved: that it is the wish and purpose of the Trustees of Cornell University to establish and maintain an Engineering and Mechanical Department either by union under one head or by division into two departments—a complete system of instruction in all that belongs to this important branch of a thorough university education.

The members of this committee approached their study with a sense of its serious importance. They early reached the conclusion that in order to realize the purposes in view some new form of organization was needed, with a new directive head with enlarged authority and responsibility. The crux of the situation was obviously the man to be called as head of the reorganized college. The field was surveyed with care and several eminent engineers were considered and their qualifications passed in review. Finally, almost exactly a year later, on June 17, 1885, this committee submitted a written report from which some extracts may be given:

. . . They have met various gentlemen eminent in the profession, and several of these gentlemen on the invitation of the president of the University, and the chairman of the board of trustees, have visited the University, looked carefully into the affairs of Sibley College, and discussed them freely with resident members of the committee. After such full consideration, the committee unanimously report in favor of establishing a professorship of mechanical engineering to be called the Sibley professorship, . . . and that there be attached to the same the directorship of Sibley College, in the duties of which shall be included the chairmanship of the faculty of mechanical engineering or mechanic arts with large powers as to the laying out of the course or courses in the department, the assignment of duties to the various professors especially connected with it, the decision as to the character and amount of various kinds of instruction, including drafting and shop work, subject to this board, the executive committee, and the president of the University so far as their spheres include his own, and having the special faculty of Sibley College as his advisory council. . . . They also recommend that the professor be immediately called and asked at once during the summer vacation to begin a careful study of the various questions involved and to prepare and have ready for this board at the coming annual meeting in October a full report on these subjects and all others which he deems best to bring before the board, and especially to include any plan that occurs to him in regard to any possible consolidation of instruction in his own and kindred departments.

Your committee, in looking about among candidates, have found various distinguished gentlemen, many of whom would do high honor to their profession and to the University. But they have unanimously concluded to recommend Professor Robert H. Thurston, LL.D., a graduate of Brown University, at present professor of mechanical engineering in the Stevens Institute at Hoboken, N. J. Professor Thurston is a gentleman of about forty-four years of age, has taken the highest rank in his profession, has published reports and various documents showing a wide range of knowledge and great depth of thought, has built up a high reputation as a teacher, has held the position of president of the American Association of Mechanical Engineers, as well as consulting engineer of the United States Navy, has been intrusted with some of the most important theoretical and practical tests by the Government of the United States and by large private corporations, and has thus gained an experience and a knowledge which cannot fail to enure to the benefit and the reputation of the Sibley College of our University. He has also proved his teaching ability by sending forth for several years past a number of graduates from the Stevens Institute who have taken high positions. And as to his standing among his associates in his profession, your committee would submit herewith certain letters from eminent mechanical engineers and others, sent directly to the members of the committee, which show that Professor Thurston is all that we could desire him to be.

The hope and belief of your committee is that if this nomination be ratified by the board, we shall have a professor and director of the fullest competence and of the highest standing, one who will at once by his counsels, his teachings, his influence upon the students, and the weight of his opinion on the country at large give to Sibley College a standing among the foremost institutions of the kind in existence.

The board of trustees lost no time in acting on this report with approval and among the minutes of this meeting it is recorded that:

Upon ballot duly had, Robert H. Thurston was unanimously elected Professor of Mechanical Engineering and Director of Sibley College.

There is also extant an account written by President White, thirty years later in 1915, and giving his recollection of the circumstances which led to the selection of Dr. Thurston out of the field of possible choice of presumably available material. Only a small part of this account can be quoted here. Speaking of conditions in Sibley College at that earlier period, he says:

. . . There were differences of opinion, some of them very acute, in the Sibley faculty, and, to the great regret and even dismay of those interested in the department, Professor Sweet left it. It was clear that a thorough reorganization was needed, and it fell to my lot to seek a professor who should take the post of director of the College, who could speak as one having authority, and who should have both theoretical and practical acquaintance with all the departments and, at the same time, a position among mechanical engineers throughout the whole country which would command respect and justify authority. But the question was where to find him.

Then, further speaking of Dr. Thurston, he says:

. . . His position was one of great eminence. He had certainly, in an astonishing degree, the qualities I sought

but his reputation as a professor at Hoboken and his distinction as a consulting engineer at New York City were such that it seemed impossible to dislodge him. All I had hoped to do was to secure from him information regarding various candidates throughout the country. A whole morning was spent by me in obtaining from him opinions regarding the work of different men who seemed promising, and at last I departed, more than ever impressed with the difficulties of the situation. Taking leave of Professor Thurston, I walked slowly down the pathway from his door, when it suddenly occurred to me to make one more attempt, such as, thus far, I had not dared. It was a sudden thought, and returning to the door, I asked Professor Thurston one more question, simply whether, under any circumstances, he could come to Cornell. He answered that he had no desire to change his surroundings at Hoboken, but he gradually confided to me that he and Mrs. Thurston had sometimes agreed that, for their children's sake and, indeed, for their own tastes, they would have preferred a life more remote from a great city and with more rural surroundings. A new hope sprang up within me. I presented the attractions of Cornell and its neighborhood, dwelt upon the possibilities of a great work under his direction, and, before leaving the house, had secured his promise to come to us.

It is well known that the qualifications of other engineers of high standing in those days were also canvassed carefully by this committee on the "Revision of Sibley College." Among these was the late William Kent, between whom and Dr. Thurston there had existed for many years a warm personal friendship. Correspondence between these two men shows that they discussed the situation frankly regarding Cornell. Up to the very last, it was generally assumed, certainly by Dr. Thurston himself, that his role was that of an adviser rather than an active candidate himself. Finally, however, in a letter from Thurston to Kent under date of June 16, 1885, he refers to a telegram from Dr. White accepting the conditions which he, Thurston, had proposed as essential to his consideration of their offer to himself of the position; he then expressed to Kent the feeling that, "had I not been in the way, you would, perhaps have gone there, and that causes me regret."

Between the accounts given in copies of Dr. Thurston's letters to Kent and Dr. White's account written some thirty years after the event, there is some uncertainty as to just when and where Thurston first received the suggestion of considering the appointment for himself. It is clear, however, that he did not give his final acceptance of the offer until certain conditions had been met, conditions which he considered essential to the proper realization of the major purposes in view.

Thus there is extant a letter written by Dr. Thurston to President White under date of May 26, 1885, setting forth his views and understanding regarding the authority and responsibility to be vested in the position to which he had been invited. This letter apparently served as the basis of a final and definite understanding regarding these matters, as evidenced by the telegram from White to Thurston, referred to in the letter from Thurston to Kent, noted above.

The attitude of the committee regarding the choice of Dr. Thurston for the position is clear from correspondence between the late Walter C. Kerr, the alumnus member of the committee, and Dr. White, showing clearly that Thurston was the choice of the committee from the start, and if there was delay in making a direct approach to him regarding the matter, it was doubtless due to a fear that with his connections in and about New York City, it would not be easy to interest him in taking up the work at Ithaca.

So in 1885 began the new era for Sibley College. In the article by Dr. White previously quoted from, and speaking of the period immediately following 1885, he says:

> So began a new era for Sibley College, for Cornell University, and indeed, for the country. . . . Professor Thurston's coming put an end to all divided counsels and began a new and better order of things.

The picture which Dr. Thurston had formed in his own mind of a college of mechanical engineering was far removed from the relatively simple plan which had so far been followed. As set forth in his first annual report, he visualized a comprehensive system of schools of engineering and of the underlying mechanic arts. In the lower or fundamental departments, these schools would offer instruction in the principal departments of industry, and then, built upon these, schools of the industries in which, to quote his own words, "the use of the apparatus of the several industries as well as the scientific and statistical facts and principles underlying them should be exhibited and illustrated by learned and expert teachers." And then, finally, schools of the constructive professions of engineering, architecture and industrial art, conducted by men distinguished in their respective professions; and then, in immediate contact with all of this splendid picture, he visualized a department of experimental research in which, again to quote his words:

> . . . men who have earned their spurs in the earlier struggles of previous years, and who have acquired a right to liberty to continue their work of solution of the great problems of the unknown, shall give themselves wholly, with all their time, talent, strength and genius, to the work which attracts them. . . .

And then he closes with the words: "All this is now and here a possibility—given capital."

As we know, not all of this splendid picture was realized. Limitations arose in time, in funds and in

human effort. Graduate schools in naval architecture and marine engineering and in railway engineering were organized and carried on for some years, but the experience with these schools showed that the idea as expressed wholly in terms of *graduate* study was somewhat ahead of the temper and demands of the time.

Just as Dr. Thurston was transferring to Cornell, the newly organizing field of electrical engineering was beginning clearly to show its importance, though few of its foremost protagonists could, at that time, have imagined the brilliant future which lay just ahead of this newly developing domain of engineering work.

A few years earlier, in 1883, a course of instruction in electrical engineering at Cornell had been organized and announced. The work was wholly in the department of physics under Professor Anthony. Dr. Thurston in 1886 took steps, through a cooperative arrangement with the department of physics, to supplement and round out the work in the department of physics with courses of instruction and training in the more directly professional phases of the subject.

Thus in the late years of the decade 1880–90, Sibley College became a college of mechanical and electrical engineering, with courses substantially the same for the first three years, but diverging each along its special line for the senior and graduate years.

Another cardinal feature in Dr. Thurston's picture of a great school of engineering—the Department of Experimental Research—was promptly organized and carried along vigorously in the lines of both mechanical and electrical engineering.

The growth of Sibley College both in numbers and in prestige was continuous and notable throughout the period of his work at Cornell. In 1885, there were seven members on the teaching staff and about sixty students. At the time of his death in 1903, the respective numbers were forty-three and nine hundred and sixty.

If the attempt be made to sum up in a single sentence the results of Dr. Thurston's work at Cornell, it may be said that they were manifest in a broadening and strengthening of the courses of instruction, and in an infusion into the work, especially of the junior, senior and graduate years, of a more distinctly professional atmosphere; in giving to the college front rank prestige and standing among the engineering schools of the country and of the world, and finally in putting the imprint of his spirit and fine idealism on some sixteen hundred graduates who passed into and through the college during the years of his life as its directing head.

In the paper by President White previously quoted from, he says further, in speaking of Dr. Thurston's work as a whole:

> He brought the institution immediately into touch with the leading men in the profession, not only in this country but in other lands. It became my duty later, at various places and institutions, in company with him, to perfect our relations with leading establishments for mechanical engineering, at home and abroad, and everywhere he was received as an authority and treated as a full equal among the leaders in the profession. At home, in his class room, in his business office, in his study, he was a center toward which students in ever increasing numbers were attracted; his books, his lectures, his talks were an inspiration. Various men prepared by him, who were destined to carry on his work, will, everyone of them, testify to his influence upon his students, upon the institution at large and upon the whole field of its activity. How Sibley College in those days, was increased in its numbers, improved in its work, and altogether, how a new epoch began, not only for itself, but for the University, is known especially by all those who had the great privilege and honor of graduating under him.

Again in a different connection but referring to these same years, President White says:

> Few days in the history of Cornell University have been so fraught with good as that on which Thurston accepted my call to the headship of Sibley College. At the very outset he gained the confidence and gratitude of trustees, professors, students, and indeed, of his profession throughout the country, by his amazing success as professor, as author, as an organizer and administrator of that department, which he made not only one of the largest, but one of the best of its kind in the world. The rapidity and wisdom of his decisions, the extent and excellence of his work, his skill in attracting the best men, his ability in quieting rivalries and animosities, and the kindly firmness of his whole policy were a source of wonder to all who knew him.

As a writer, during these years, Dr. Thurston maintained a steady pace, both in the production of books and of papers on technical subjects.

At Stevens Institute he had outlined, in mind, a great series of engineering texts. Of these, his treatise on "Friction and Lost Work in Machinery and Millwork" was completed at Stevens Institute in 1885, just as he was transferring to Cornell. He had projected two great works, one on the steam boiler and another on the steam engine. Some work had been done on these books, but they were unfinished, and to their completion and publication he gave much time and energy during his earlier years at Cornell. The "Manual of Steam Boilers" was published in 1888 and that on the steam engine in 1891–92. In addition to this, there was, during the entire period of his life at Cornell, continued work on revision of books already published as well as a continued output of papers on technical and more general subjects, astonishing in their number and in the wide variety of topics treated.

In addition to the work of organization, administration and instruction in Sibley College and to his tre-

mendous output of technical writing, Dr. Thurston found time for much service of a public character. Only a few illustrations need be given. Thus: service as a member of the New York State Commission on Voting Machines; service as a member of a New York State Commission to report on a Modern Rifle for the National Guard; service on the United States Industrial Commission on Improvements in Manufacturing Methods and on the United States Commission on Safe and Vault Construction for the U. S. Treasury.

In 1889 he attended the French Exposition in Paris and took a prominent part as vice-president of one of the juries. Again in 1893 he served as a member of the Jury of Awards at the World's Columbian Exposition in Chicago. Again and in widely different lines Dr. Thurston served for six years as a member of the board of aldermen for the city of Ithaca, for most of the time as chairman of the finance committee and at a later time as a member of its board of water commissioners.

Dr. Thurston was always ready and willing, within the limits of his obligations otherwise, to undertake service for the public good or where he believed that his training and experience might be of specific and definite value. He was, furthermore, sufficiently human to distinctly enjoy public service of an important character and where the work was such as to bring him into contact with other men of note.

The family life of Dr. Thurston was most fortunate and happy. His family comprised his wife, three daughters and, for portions of the time, Mrs. Thurston's mother and sister, Mrs. and Miss Boughton.

Soon after coming to Cornell he built a comfortable house on East Avenue, and I can not refrain from adding here the source of the funds for the construction of this house. In connection with the capture of the blockage runner *Princess Royal* during the Civil War, and to which reference has been made by Admiral Brown, Thurston received as prize money the sum of $2,291.99. This was first invested in government bonds and later in real estate, first in Providence, R. I., and later in Hoboken. As a result of the advances in value realized in these various transactions, he was able, selling out these holdings, to build his house at Cornell; and it was always a matter of much satisfaction to him that, through the judicious use of this prize money, he had been able to furnish the major part of the funds necessary for the provision of comfortable housing for himself and his family for the remainder of his days.

I have spoken thus far chiefly of Dr. Thurston as an educator; somewhat incidentally as an engineer, as a public servant and as a writer. I can not bear to close my tribute, however, without a word regarding him as a man among men, as a friend and neighbor, as a social unit in the delightful atmosphere of the Cornell campus. If I were to attempt the briefest possible specification of the character of Dr. Thurston, I would say that the controlling elements in this complex were an abiding faith in himself, unwavering persistence toward his objectives and a steadfast optimism, all combined with generous and kindly human impulses toward those about him, with a serene, cheerful and confident outlook regarding both present and future. He was always ready to accept responsibility and to undertake any task which seemed to fall in the line of his duty, which seemed worth while and for which the means were at hand. These characteristics are illustrated throughout his entire life.

I would not imply, however, that his faith in himself was such as to lead to reckless and ill-considered measures. It was tempered with a wise restraint. In the face of important steps his strategy included not only a most careful survey and analysis of the matter by himself, but the taking of counsel with those in whose opinion he had confidence. In the end he might or might not follow advice given, but if not, it was always after a careful and generous weighing of such counsel given. He was ready at the last to accept responsibility for the final judgment and to make it in the light of all the assembled evidence which he could bring to bear on the problem.

No characteristic was perhaps more marked than his persistence in following through in the face of discouraging obstacles. Repeated return to the attack, again and again, always with the same cherry optimism, gives the secret of the successful outcome of some of his undertakings carried forward against obstacles which might well have discouraged a soul less persistent, less hopeful and less assured of the righteousness of the ends for which he was working.

Members of the board of trustees of those days have told in later years of the cheerful and unruffled manner in which he would accept unfavorable action with regard to the grant of funds or regarding some other measure which they might not find themselves in a position to forward as rapidly as he might wish. With no exhibition of impatience or disappointment, he would bid them a cheery and courteous good day, with the assurance that in due time he would venture to present the matter again in the hope that it might then commend itself to their more favorable consideration. One of the trustees of that period, speaking of these matters, once remarked that "it was no wonder that a man like that got what he wanted in the end."

Not many in this room have, perhaps, seen Dr. Thurston in the flesh. I wish that I might give some adequate picture of him, for example, in his daily walk across the campus from his home to the Sibley buildings. The late Dr. W. A. Hammond, of the department of philosophy at Cornell, who will be remembered by many in this audience, once told me

that in going to classes in the morning, his path often crossed that of Dr. Thurston and that he grew to look forward to these meetings with anticipation; that Dr. Thurston's manner of saying "Good morning" would always make the day seem brighter and fairer for him.

In physical frame, Dr. Thurston was moderate in stature, rather spare of build, erect in carriage and mien. His hair with full beard and moustache were in early and middle life black, becoming gray with the passing years. His eyes were dark and piercing, often with something kind and quizzical shining through. His gait was rapid and firm, with figure trim and erect, a characteristic tracing back, perhaps, to his naval training, but none the less a natural expression of his personal energy and normal outlook on the world about him. This daily walk between his house and office, with black portfolio of lecture notes under his arm, body erect, shoulders back, head up and eyes to the front, formed a picture of personal dignity and of purpose toward an intended goal which will surely long be remembered by those who saw this as a familiar sight during the years of his life at Cornell.

I wish that there were time for some of the anecdotes which illustrate his kindly nature, his intense human sympathy, his resourcefulness in adapting himself to the unexpected, all combined with his optimistic outlook on his environment, his abiding faith in the ultimate working out of the great enterprise in which he was embarked, but time presses and I must close.

The fall of 1903 found Dr. Thurston in seeming good health, in the midst of interesting and important work and apparently with many years of fruitful activity before him. On the occasion of his birthday, thirty-six years ago to-day, Mrs. Thurston had arranged for a small dinner party of intimate friends. Sitting quietly in his home waiting for the arrival of these friends, the final summons came—apparently through an aneurism of the heart. Peacefully and with hardly a movement he passed on, and so out of the busy life in which he had wrought so long, so courageously and so well.

In the shuffling of human characteristics by the Fates, only too rarely do the combinations give us a man such as was Dr. Robert Henry Thurston. We shall not soon look upon his like again.

PHOTOPERIODIC ASPECTS OF PHASIC DEVELOPMENT

By Professor W. F. LOEHWING

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THE concept of phasic development of plants has, in less than a decade, profoundly influenced the fundamental philosophy of plant growth as well as theory and practice in plant physiology, ecology, agronomy and genetics. This theory emphasizes especially the differences between the thermo- and photo-phases of plant growth. In view of the fact that recent advances in our knowledge of photoperiodism show variable effects of a given light period upon the different processes involved in sexual reproduction, it now seems desirable to evaluate this evidence to determine the possible desirability of subdividing the photophase of plant development into (*a*) an initial flowering phase as distinguished from a subsequent (*b*) gametogenic phase concerned with the formation of viable gametes.

When the photoperiodic concept was first clearly enunciated by Garner and Allard (1920), formation of macroscopic flowers in known periods of diurnal illumination was taken as a criterion of photoperiodic response. It was soon learned, however, that plants receiving minimal periods of photo-induction frequently produce flowers of anomalous shape and marked sterility. *Xanthium* of one short photoperiod, for example, exhibits marked pollen sterility (Hamner and Bonner, 1938; Neidle, 1939). Kirichenko and his associates (1934–36) had also previously observed that though flowers developed in *Triticum erythrospermum* when exposed for several weeks to a daily two-hour photoperiod, pollen when present was invariably sterile. The data of Kirichenko and other investigators indicate that the development of viable pollen requires (*a*) a longer period (6 hours or over) of photo-induction, consisting both of more days and longer daily light periods than necessary for the differentiation of pistil and ear. In conformity with other light-induced, formative processes, once the requisite period of photo-induction has been supplied, *Triticum erythrospermum* then continues to produce viable pollen indefinitely in all ranges of illumination from continuous day to continuous night. Oleson (1938) observed similar conditions in *Fuchsia* and *Begonia*.

The work of Rosenbaum (1937) on 18 varieties of soybean indicates that not only stamen but also perianth and ovule development can be suppressed by extremely short day length (8 hours or less), thus reducing the fruits to parthenocarpic, seedless pods. A 13-hour day, on the other hand, results in normal flowers producing pods with the usual complement of viable seeds (Hamner, 1938). Earlier still, Schaffner (1927–30), Richey and Sprague (1932) noted the absence of tassels in corn grown during very short

photoperiods, especially in low intensities of light, and that ears formed normally, or sometimes apically in place of tassels. Short day thus rendered corn dioecious. In cucumbers, it has been known for many years that short day of low intensity results in a preponderance of pistillate flowers (Edmond, 1930; McCollum, 1934; Miller, 1938; Zukova, 1938). The production of staminate flowers requires longer days and higher light intensity. Allard (1938) found that the flower habit of the hog peanut changed from hypogeic to cleistogamous and finally to anthesitic as the photoperiod increased. Aerial flowers required a 13½ hour day for their formation, but hypogeic forms developed in as little as a five-hour light period.

It is evident from the foregoing data that the photoperiod exerts a variable effect on the different parts of the flower, just as it does upon different vegetative structures. Thus, if flower fertility is to be made the criterion of photoperiodicity, the conditions will be somewhat different from those necessary to cause the inception of primordia alone.

The contrast in the photoperiodic demands of staminate and pistillate tissues is a manifestation of sex, and it is to be expected that these organs will differ as much in metabolism and composition as in mode of origin. In fact, as the evidence on flower physiology accumulates, it shows increasingly that the most profound compositional and developmental changes in the plant's entire existence occur in the brief period of floral differentiation, a condition as yet inadequately appreciated, probably due to the rapidity, extreme localization and inconspicuousness of the changes involved. The technical and analytical difficulties in physiological studies of this sort are obvious, and they constitute a further reason for the meagerness of quantitative data on reproduction. Once the importance of such information is generally recognized, it is to be expected that adequate techniques and increased investigation will follow. It would be helpful, however, if some consensus could be reached as to precisely what constitutes flowering. If inception of floral primordia is to be the criterion, then there is definite need of distinguishing gametogenesis from the origin of the other floral parts, since inception of primordia and perianth development are no absolute guarantee of the production of viable gametes.

The common denominators of flowering, in both long- and short-day species, such as the non-specific character of the florigenic hormone, suggested by the researches of Cailachian, Murneek, Loehwing, Hamner and Bonner and many others, as well as similarity in stem anatomy of all flowering types as worked out by Roberts and his associates, are all valuable inventories of the various attributes of normal flowering. They still leave much unanswered, however, as to the physiological nature of sporogenesis and the differentiation of the sex organs. In addition to those features which are common to all plants in the flowering phase, we must identify the physiological stimuli responsible for differences between pistils and stamens.

More than a decade of research by the writer and his students upon dioecious species suggests that, among the most important physiological differences of the sexes, are the oxidation-reduction enzymes, marked quantitative if not qualitative differences in soluble carbohydrates and qualitative contrasts in proteins. Mild hydrolysis of proteins in sexually differentiated hemp plants discloses arginine and lysine but no proline or histidine in staminate individuals, while pistillate plants are the exact converse. Tests for these amino acids in foliar tissues of vegetative plants without flower primordia enable one to forecast the eventual sex of the mature plant (Kiesel and Pachewitsch, 1938; Loehwing, 1939). Inception of staminate organs seems to be characterized by a preponderance of soluble sugars and presence of oxidase. Pistillate loci have a preponderance of nitrogen and marked reducase activity (Loehwing, 1937; Stanfield, 1937). Though the foregoing appear to be significant physico-chemical differences between the sexes, we have not as yet successfully distinguished cause and effect, nor have we the desired degree of voluntary control over carpo- and andro-genesis.

Not only are the photoperiodic requirements for development of pollen and embryo sac different from one another, but they in turn also differ from the post-fertilization processes of fruit enlargement. Fertilization marks the inception of the new sporophyte phase and as such, essentially the recommencement of vegetative activity, temporarily of a parasitic sort with a high food demand. In many plants, it seems that the photoperiodic conditions favorable for fruit development are more similar to those for vegetative growth than for flowering. In brief, the optimal photoperiodic conditions change as the plant progresses from inception of primordia to differentiation of floral parts and finally to fruiting.

This fact has been recognized in varying degrees by many investigators, but has recently been well formulated by Eguchi (1937), who suggests a double photoperiodic classification for plants. Eguchi's system not only recognizes but definitely emphasizes the difference in the light optima of flowering and fruiting. Following Garner and Allard's classification, he postulates three fundamental types of plants, namely, long day, short day and photoperiodically indifferent. With respect to flowering, the plant may have a short optimal period but a long or indifferent light requirement with respect to fruiting. There are, then, nine possible permutations of these three classes as given in Table 1:

This synoptic classification is perhaps a bit extreme

TABLE I

Optimal photoperiods for: Flowering	Fruiting	Representative species
Short	Long	Strawberry, Cineraria
Long	Long	Oxeye Daisy, Spring Barley
Long	Short	*Physostegia virginiana, Boltonia latisquama*
Short	Short	Soybeans, *Cosmos bipinnatus*
Long	Indifferent	*Phlox paniculata*
Short	Indifferent	Late rice varieties
Indifferent	Short	*Chrysanthemum articum*
Indifferent	Long	Spinach, Many wheats
Indifferent	Indifferent	Pepper, Early rices, *Stellaria media, Poa annua* (Tincker, 1924) Buckwheat (Arthur, 1930)

and as a result not wholly clear. A plant may be long day with reference both to flowering and fruiting, yet nevertheless have a shorter optimum by several hours for fruiting than for flowering. It will be noted that this classification of Eguchi controverts the original suggestion of Lysenko that long-day species are at their optimum in continuous-day and short-day species in continuous-night. Even with reference to flowering alone, we already have abundant evidence that this interpretation by Lysenko is too extreme (Singh, 1937; Allard, 1938; Borthwick and Parker, 1938; Murneek, 1937; Celjadinova, 1937).

The fact that the optimal photoperiod for fruiting is different than for flowering in some species, often causes delay in the enlargement and even abscission of the earliest fruits. Oleson (1938) noted that after the first crop of *Begonia* and *Fuchsia* fruits appeared in early spring, about four to six weeks elapsed before these began to enlarge under conditions of normal day-length. Many fruits abscissed during the period from late February to late April. Neither pollination with viable pollen nor stimulation with indole acetic, indole butyric or phenyl acetic acids was capable of inducing ovary growth until late April or early May. These earliest successful fruits, both natural and parthenocarpic, were seedless. As the days became longer, ovules filled out in both naturally and artificially stimulated fruits. In cucumbers, a similar favorable effect of long day was noted in setting of natural and parthenocarpic fruits by Miller (1938). Whyte (1939) has recently suggested that in fruit growth, temperature plays a somewhat more important role, along with the photoperiod, than it does in the pre-fertilization processes.

The period of embryo development is preceded by extensive mobilization of food reserves, so profound that the entire plant is involved. Renewed root growth and absorption is a concomitant of this phase, making the applications of soil nutrients peculiarly effective at this time (Polster, 1938; Kraus and Kraybill, 1918; Hamner, 1938; Borodin, 1931; Auchter, 1924; Combes, 1935; Howlett, 1934–36; Murneek, 1937; Dobrunov, 1938).

If we consider photoperiodic responses as one stage of phasic development in the sense of Lysenko's concept, a number of open questions still remain. Though Lysenko originally considered the thermal and light phases qualitatively distinct, there is now evidence of overlap between them as shown by the ability to complete a portion or all the essential photoperiodic induction in swollen seeds and seedlings undergoing low temperature vernalization (Wöber, 1936). Harder (1937) has shown this to be true in *Sinapsis, Agrostemma* and winter rye. If the thermo- and photophases are wholly separate, we as yet possess neither readily recognizable criteria of the completion of the former nor inception of the latter. Though the transitions are functional rather than structural, they should be identifiable nevertheless. Changes in permeability, oxidase enzymes and protein iso-electric point have been suggested, but the data are thus far too meager to be conclusive (Bassaraskoja, 1936; Richter, 1936). There also remains the question as to why morning light is more effective than evening light in a long-day species as shown by Fabian (1938) for *Ullucus* and contrariwise for short-day forms as shown by Bünning (1936) for *Phaseolus.*

Lysenko and Whyte (1939) have also postulated the irreversibility of phases. Yet it is possible to rejuvenate a reproductive plant photoperiodically, making it again vegetative. While in some cases a shift from reproductive to vegetative photoperiod leads to the death of the apical meristem and initiation of subsequent vegetative growth from previously dormant lateral buds well down on the stem, as in hemp, there are, however, also cases of vegetative proliferation of the apical meristem of flowering plants, as in the *Compositae.* Whether such rejuvenation is possible only in plants on the threshold of reproduction but not in those which have been exposed for a considerable length of time to an optimal reproductive photoperiod is not yet definitely settled. It seems likely, however, that the rigidity of Lysenko's concept as to irreversibility in the light phase may, on the basis of recent data, undergo modification as already has the previous belief in irreversibility of the vernalization phase. Instances of devernalization with age and unduly prolonged low temperature treatment appear to be well established (Gregory and Purvis, 1937–38).

When a rejuvenated plant is shifted from a vegetative to a slightly reproductive photoperiod, certain anomalous yet progressive transitional intergrades from vegetative to reproductive structures are often obtained. Older portions of the stem produce green and leafy perianth segments devoid of stamens and pistils. Younger regions near the tip of the main axis produce increasingly perfect flowers until normal, functional flowers appear at the apex. This response often occurs in ornamentals of the *Solanaceae,* such as *Petunia.* Another aspect of reversion is the effect of change in temperature by means of which a short-day

pe such as *Xanthium* can be induced to exhibit long-y response (Gilbert, 1926, 1934).

The recent observation by Melchers (1939) that a egetative scion of tobacco is able to induce flowering a vegetative stock in the first year of the biennial pecies, *Hyoscyamus niger*, presages an early and pro-ound revision of the current form of the florigen oncept. Melchers' painstaking experiments were con-lusive and clearly significant statistically. With ref-rence to the normal flowering of biennials, Melchers ostulates the formation of a new hormone, tentatively esignated "vernalin," at low temperatures at the end f the first season. Upon this "vernalin" in turn epends the ability to produce florigen in the repro-uctive photoperiod of the second year. Melchers oints out that our knowledge of the reproductive hysiology of biennials, such as *Hyoscyamus niger* ith which he worked, is almost as nebulous as our nderstanding of the day-neutral group of plants. Melchers' results also contradict the suggestion pre-iously made by Cailachian that the photoperiodic ffect is proportional to the area of foliage. Melchers noted no such quantitative relationships. Recent temperature studies suggest that radical revisions are also imminent in regard to the supposed indispensability of light for inception of flowering in the so-called photophase (Roberts, 1936–37–38–39; Thompson, 1933–36; Chroboczek, 1934).

In conclusion, it would seem, on the basis of recent evidence, that the thermo- and photo-phases are not as rigidly set apart nor as irreversible as originally suggested by Lsyenko. Further, it may prove desirable and conducive to a better understanding of reproduction if the photophase is subdivided into a flowering and gametogenic stage. If the profound and rapid transformations occurring between inception of flower primordia and fertilization, namely, the phenomena of sex, are studied as intensively as vernalization and photoperiodism, they promise to contribute fully as much as the former to our understanding of reproduction. If speed and magnitude of transformation be criteria of vital significance, the gametogenic or sexual phase *per se* represents the stage of most profound alterations in the ontogeny of the higher plants.

OBITUARY

MARGARET FLOY WASHBURN
1871–1939

MARGARET FLOY WASHBURN, emeritus professor of psychology at Vassar College since June, 1937, and a member of the Vassar faculty for thirty-six years, died after a long illness at Poughkeepsie, N. Y., on the afternoon of October 29, 1939. Her illness dated from a cerebral hemorrhage suffered on March 18, 1937—on the eve of the meeting of the Eastern Psychological Association, which was held at Vassar College in observance of her approaching retirement. She was at the time of her death in her sixty-ninth year, having been born in Harlem, New York City, on July 25, 1871, the only child of Rev. Francis and Elizabeth Floy (Davis) Washburn.

Professor Washburn was one of the foremost women in American science and was long recognized as a leader in her field. Her services and contributions to psychology were many and outstanding, and she received in recognition of them the highest honors and awards at the disposal of her confrères.

In 1919–1920, when the Division of Psychology and Anthropology of the National Research Council was formed, she acted as a representative of psychology, and again in 1925–1928. In 1921, she was president of the American Psychological Association. That same year she was awarded the prize of $500 by the Edison Phonograph Company for the best research on the effects of music, an investigation, done in collaboration with a colleague in the Vassar Department of Music, on "The Emotional Effects of Instrumental Music." In 1927, she was vice-president of Section I (Psychology) of the American Association for the Advancement of Science and was the recipient of a *Festschrift* and of an honorary degree of D.Sc. The *Festschrift,* volume 39 of *The American Journal of Psychology,* was dedicated to her by its authors, thirty-two colleagues from the various editorial boards upon which she had served, "in recognition of thirty-three years of distinguished service to psychology." The degree, *honoris causa,* was conferred upon her by Wittenberg College during the International Symposium on Feeling and Emotion that was held there at the dedication of the new psychological laboratory. She was elected, in 1929, to the International Committee on Psychology (the governing body of the International Congresses) and to the Society of Experimental Psychologists; and, in 1931, to fellowship in the National Academy of Sciences (the second woman to receive that honor, Dr. Florence Sabin having been elected before her in 1925). She was president, in 1931, of the New York Branch of the American Psychological Association (now the Eastern Psychological Association) and chairman of the Society of Experimental Psychologists. In 1932, she was the U. S. delegate to the International Congress of Psychology in Copenhagen. Professor Washburn was also a member of the National Institute of Psychology, the American Philosophical Society, the New York Academy of Sciences, the American Association of University Professors and Sigma Xi.

Besides publishing nearly 200 scientific articles and

reviews, Professor Washburn translated Wundt's "Ethical Systems," 1897, and wrote two books: "The Animal Mind," 1908, and "Movement and Mental Imagery," 1916. "Animal Mind" went through three more editions, every one thoroughly rewritten and enlarged (1917, 1926 and 1936). The first edition was translated into Japanese in 1918. "Movement and Mental Imagery," a development of her article in G. Stanley Hall's *"Festschrift"* in 1903, marked her break with Titchener's doctrine and her espousal of a motor theory of consciousness for which she was thereafter widely known. Between 1905 and 1938, she published in *The American Journal of Psychology* sixty-eight studies from the Vassar Psychological Laboratory. During this period she also gave unsparingly of her time to editorial work. She was co-operating editor of *The American Journal of Psychology,* 1903–1925 and co-editor since 1926; cooperating editor of the *Psychological Bulletin,* 1909–1915; associate editor of the *Journal of Animal Behavior,* 1911–1917; advisory editor of the *Psychological Review,* 1916–1930, and associate editor of the *Journal of Comparative Psychology,* 1921–1935.

Professor Washburn was an able and accomplished woman, the product of a good inheritance and a good environment. In her autobiography, published in 1932 in Volume II of the "History of Psychology in Autobiography"—a series of biographies to which the foremost psychologists in the world were invited to contribute—she tells that her ancestry was Dutch and English: Long Island and Westchester County Quakers and Maryland Cavaliers, with a dash of Connecticut Yankee. Most of her ancestors were in America before 1720. She was a precocious child. Though she did not enter school until she was seven years old, she had learned to read and write long before then. As a child, as throughout her life, she was an omnivorous reader. Her first school was one conducted in the home of a retired Presbyterian minister by his accomplished daughters. From them she learned the rudiments of mathematics and acquired a good foundation in French and German. When she was eleven years old, her father was called to the rectorship of the Episcopal Church in Kingston, N. Y. There she attended the public schools. Her progress was rapid, and she was graduated from the Kingston High School at fifteen years of age, in 1886. That fall she entered Vassar College. Due to a lack of Latin, which was required for college entrance at that time, her first year was spent in the preparatory department. In 1891, she was graduated from Vassar with the acquisition of an abiding interest in science and philosophy.

Hearing of the psychological laboratory that had just been opened by Cattell in Columbia University, she determined to become his pupil—though the graduate school at Columbia was then closed to women. Characteristically she persevered in her determination to be admitted to his classes and finally succeeded, as a result of special permission by the trustees of the university, in registering as a "hearer." Thus she was a pioneer in the struggle for equal educational opportunities for women. Cattell treated her as a regular student and permanently fixed her interest in psychology. As no fellowship was available to her at Columbia, she applied for and was granted a fellowship in the newly established Sage School of Philosophy at Cornell University. In 1892 she became Titchener's first doctoral student. After a year at Cornell, Vassar College awarded her an M.A. degree *in absentia* for work done under Titchener. A year later, in June, 1894, she obtained the Ph.D. degree from Cornell University. Her doctoral dissertation, "The Influence of Visual Associations on the Spatial Perceptions of the Skin," was published by Wundt in German in his *Philosophische Studien*—the first foreign study printed in that journal. Miss Washburn's doctoral minors were ethics with Schurman and philosophy with Albee, Hammond and Thilly.

In the fall of 1894 she went to Wells College as professor of psychology, philosophy and ethics. She remained there for six years. Then followed two years at Cornell as warden of Sage College—that is, head resident of the women's dormitory—and, during the second year, as lecturer in psychology. She gave two courses: social psychology, based on Wundt's "Völkerpsychologie," and animal psychology, which was to remain a life-long interest. Finding the duties of warden ("concerning oneself with the behavior of other people") uncongenial, she accepted at the end of two years the offer of an assistant professorship with full charge of the department of psychology at the University of Cincinnati. Though conditions there were to her liking, she could not resist the call of her *alma mater* and so went to Vassar College in the fall of 1903 as associate professor of philosophy. Her duties were at first divided between philosophy and psychology, but in 1908, psychology and philosophy having been divorced, she became professor of psychology and head of the newly created department.

Professor Washburn was an indefatigable and persistent worker. Except for the summers of 1913–1917, when she taught in the summer school of Columbia University; the spring of 1928, when, on sabbatical leave, she took a Mediterranean cruise; and the summers of 1929 and 1932, during which she took short trips to England and Copenhagen—she never was far nor long away from her work in her laboratory and study at Poughkeepsie. That she was also an inspiring teacher is attested by the growth of her department, by the many studies that came from her

laboratory and by the number of her students who continued in psychology.

Hers was strictly an undergraduate department. As far as graduate study was concerned she was a proponent of coeducation. She wrote in her autobiography, "I deprecate graduate study for women at any but coeducational universities." True to her convictions, she encouraged her students to go to such universities for their final training. Many did, and wherever they went—to California, Columbia, Cornell, Harvard (Radcliffe), Illinois, Indiana, Iowa, Michigan, Ohio State, Yale—they made splendid records.

Professor Washburn's life and work should be an inspiration to women as it is a testimonial to the value of the equality of educational opportunity for which she determinedly strove.

KARL M. DALLENBACH

CORNELL UNIVERSITY

OSCAR HENRY PLANT

ON October 1, 1939, Dr. Oscar Henry Plant, professor of pharmacology in the College of Medicine of the University of Iowa, apparently in good health and at the height of his career, passed away suddenly, following an attack of coronary insufficiency. He is mourned as a teacher, a scientist and a man.

Dr. Plant was born at Lawrence, Kansas, on September 30, 1875, the only son of Thomas Henry and Anna Stewart Plant. Early in his boyhood his family moved to East Texas. As educational facilities there were limited, he spent his winters with his grandparents in Topeka, Kansas, where he attended the public schools.

Dr. Plant joined his father when the latter removed to Galveston, and his high-school work was completed in that city. At the age of fourteen he determined to enter the field of medicine. With this object in view, he spent all his spare time and vacations working as an assistant to a Galveston pharmacist. This experience was a factor in directing his interest toward the field of pharmacology, to which he contributed so much in his later years. He entered the Medical School of the University of Texas in 1897 and graduated with the class of 1902, being compelled to drop out for one year to replenish his finances.

When a senior in medicine, Dr. Plant was selected by Dr. W. S. Carter, then professor of physiology, as an instructor in that department. To Dr. Carter's help and influence may be attributed his choice of a teaching career and the inspiration for his great success.

After graduation, Dr. Plant entered upon a five-year period of active practice in Galveston, retaining, however, his instructorship in physiology. In 1907 he decided to follow teaching as a career and became assistant professor of physiology.

Prior to this time instruction in pharmacodynamics had been carried on by the lecture and text-book method. Realizing a deficiency in this method, Dr. Plant undertook, on his own initiative, to conduct experimental demonstrations of the action of drugs on animals. His resourcefulness and ingenuity in this important field were always a source of wonder to his associates. His experiments were always worked out to the minutest detail, so that students never had any difficulty in properly performing the laboratory work. His most noteworthy contribution to research while at Texas was a study of fat absorption from Thiry-Vella loops, published in the *American Journal of Physiology*.

In 1911 Dr. Plant was called to the University of Pennsylvania as instructor in pharmacology under Dr. A. N. Richards. He was advanced to an assistant professorship in 1914 and to the rank of professor in 1918. He was associated with Dr. Richards in the well-known research on kidney function carried on by Dr. Richards and his colleagues.

In 1920 Dr. Plant was appointed professor and head of the department of pharmacology at the University of Iowa, in which position he continued until his death. The facilities for the laboratory teaching in pharmacology were very meager, so with characteristic energy he set about organizing the courses and building up what became in a comparatively short time one of the outstanding teaching laboratories of the United States. At the same time he developed an extensive research program. His outstanding contributions were studies of the action of morphine on the alimentary tract and his fundamental work on the problem of morphine addiction. Other contributions were studies on the cardiac action of camphor and a series of papers on the effects of carminatives.

Dr. Plant was a member of the American Physiological Society and the American Society for Pharmacology and Experimental Therapeutics. He was treasurer of the latter society from 1929 to 1934, vice-president from 1935 to 1936 and was elected president in 1939. He was also a member of the Society for Experimental Biology and Medicine and the American Association for the Advancement of Science. He was intensely interested in all organized scientific activities and gave his unstinted time and devotion to their welfare. His election to the presidency of the American Pharmacological Society is best proof of the high esteem in which he was held by his colleagues in the society. For the past few years he served on the Board of Editors of the *Journal of Pharmacology and Experimental Therapeutics* and the *Proceedings* of the Society for Experimental Biology and Medicine. Papers submitted to him for criticism always received the most careful attention. In addition to his many other duties, he devoted much

time during the past year in directing the preparation of a Formulary for the University Hospital, copy of which was distributed to the various departments the day before he died.

In spite of all his many official duties, Dr. Plant found time for many outside interests. He was keenly interested in bird life, wood carving, fishing and stamp collecting. He was always immensely thrilled by the sight of the first migrant birds in the spring and spent many hours in the City Park with his field glasses.

In 1904, Dr. Plant was married to Ella Mary Beissner, of Galveston. She and their son William are the only direct relatives to survive him. Although he had only one son of his own, he often said that there were former students all over the United States who were like sons to him.

Dr. W. S. Carter, under whom Dr. Plant began his career, testifies to his character and personality in these words:

> His relations with the students were always most pleasant. He understood their difficulties and was most patient and sympathetic in helping them. He endeared himself to his students and to his colleagues, so that he commanded at all times the highest respect and admiration of those who knew him.
>
> His delightful personality, unusual ability, faithful and enthusiastic devotion to duty, and his loyalty to his friends, all contributed to a warm friendship which I prized very highly and which lasted throughout his lifetime. His death is a great loss to his many friends, as well as to his family and to the university which he served so well.

Those who were associated with Dr. Plant at the University of Iowa feel that Dr. Carter's tribute expresses the feeling of all his colleagues, friends and students. His loss will be keenly felt in the university and the community, and he and his work will not soon be forgotten.

E. G. GROSS
I. H. PIERCE

THE STATE UNIVERSITY OF IOWA

RECENT DEATHS AND MEMORIALS

DR. ROYAL N. CHAPMAN, dean of the Graduate School of the University of Minnesota since July, died on December 2. He was fifty years old. Dr. Chapman resigned last year as director of the experiment station at the Pineapple Producers Cooperative Association, of Honolulu, to return to Minnesota, where he was formerly chief of the division of entomology and economic zoology of the School of Agriculture of the university.

DR. SENECA EGBERT, emeritus professor of hygiene at the Medical School of the University of Pennsylvania, known especially for his work in public health, died on December 6. He was seventy-six years old.

BENJAMIN WALLACE DOUGLASS, formerly state entomologist of Indiana, died on December 6 at the age of fifty-seven years.

THE death is announced of Dr. Arthur P. Beddard, chairman of the British Pharmacopoeia Commission, formerly lecturer in medicine in Guy's Hospital, London.

DR. VIGGO CHRISTIANSEN, formerly professor of neurology at Copenhagen and president of the Third International Neurological Congress, died suddenly on November 3.

CHARLES VALLIANT, of Paris, known for his work as a radiologist, died on December 4 at the age of sixty-seven years.

PROFESSOR UGO MONDELLO, of Florence, Italy, seismologist, formerly director of Ardenza Observatory, died on December 3 at the age of sixty-one years.

THE Louisiana Iris Conservation Society held a memorial meeting at Tulane University on September 29 as a tribute to the work of Dr. John K. Small, who until his death on January 20, 1938, was chief research associate and curator at the New York Botanical Garden and who was responsible for the discovery and preservation of many of the native irises of the southern states.

IN a note in SCIENCE, page 533, in regard to a portrait of the late Henry Smith Munroe, formerly dean of the School of Mines of Columbia University, his surname was unfortunately omitted.

SCIENTIFIC EVENTS

MINING EDUCATION IN ENGLAND

IN the annual report of the governing body of the Imperial College of Science and Technology, South Kensington, as summarized in the London *Times*, it is stated that mining as a career does not appear to make a great appeal to boys in the English public secondary schools. It is hoped that the provision of certain scholarships may help to spread at schools knowledge of the interest and advantages of this career, while making it possible for the necessary training to be given to a number of boys who might otherwise be prevented from obtaining it for financial reasons.

The governing body expresses its thanks to mining companies that have contributed £2,700 a year, in the first instance for seven years, to provide scholarships

to be awarded to suitable candidates desiring to enter the Royal School of Mines. Provision has also been made for two, and possibly for more, scholarships for students taking an honors course in oil technology.

The Appointments Board of the Imperial College, in an appendix to the report, states that the year was a record one for the employment of college-trained graduates. Of the 247 on the register of the board only 11 were unemployed at the end of the year, and unemployment had never been so low. A remarkable feature was the persistently small number of candidates from the Royal School of Mines during the past few years; as was the case last year, there had been very many more demands for men trained in mining, metallurgy, oil, etc., than could be met.

The total number of students during the year was 1,143, made up of 530 at the Royal College of Science, 123 at the Royal School of Mines, and 490 at the City and Guilds College.

In a review of research development during the year it is reported that the Rockefeller Foundation has made an appropriation of a sum not exceeding £12,000 for researches on vitamins, sterols and related compounds, under the direction of the professor of organic chemistry, during the seven years to September 30, 1945. New subjects of research being investigated with the assistance of outside bodies included infestation of stored grain and grain products by insects, wear problems, investigation of thin carcinogenic films, combustion characteristics of coal dust and diseases of spring lettuce.

LECTURES TO THE LAITY OF THE NEW YORK ACADEMY OF MEDICINE

THE Fifth Series of Lectures to the Laity sponsored by the New York Academy of Medicine opened on Thursday, November 30, with an address entitled "The Inheritance of Mental Disease" by Dr. Abraham Myerson, clinical professor of psychiatry at the Harvard Medical School. The presiding chairman was Dr. Malcolm Goodridge, president of the academy.

The lectures are given on Thursdays at 8:15 P.M. in the building of the academy at 2 East 103rd Street. Subsequent lectures will be as follows:

December 28. The Ascent from Bedlam, Richard H. Hutchings, M.D., professor of clinical psychiatry, emeritus, Syracuse University Medical College. "The remarkable growth of the mental hospital. Is mental disease increasing? New standards for mental health." *Presiding chairman,* A. A. Brill, M.D.

January 25. The Story of our Knowledge of the Blood, Paul Reznikoff, M.D., assistant professor of clinical medicine, Cornell University Medical College. "Blood has had a fascinating importance for humans since ancient times. The invention of the microscope, and modern knowledge of blood. The great medical significance of the recent hematological discoveries." *Presiding chairman,* Lloyd F. Craver, M.D.

February 29. The Romance of Bronchoscopy. Chevalier Jackson, M.D., and Chevalier L. Jackson, M.D., professors of broncho-esophagology, Temple University School of Medicine, Philadelphia. "The bronchoscope, what it is, how it is used and what is seen through it will be demonstrated by lantern slides and motion pictures." *Presiding chairman,* Charles F. Tenney, M.D.

March 28. The Story of the Viruses, Thomas M. Rivers, M.D., director, the Hospital of the Rockefeller Institute for Medical Research. "The development of knowledge of viruses; an historical review, and an evaluation of that knowledge in relation to certain other biological facts." *Presiding chairman,* Wilbur A. Sawyer, M.D.

April 25. Chemical Warfare against Disease, Perrin H. Long, M.D., associate professor of medicine, the Johns Hopkins University, Baltimore. "It has been the hope of physicians for many years that chemical compounds would be available which would cure bacterial infections. Since the introduction of Prontosil, remarkable strides have been made in the treatment of bacterial infections with sulfanilamide or its derivatives. It now appears as though within time the majority of infectious diseases may be conquered by chemical products." *Presiding chairman,* William S. Ladd, M.D.

STATEMENT OF THE BOARD OF TRUSTEES OF BIOLOGICAL ABSTRACTS

THE Board of Trustees of *Biological Abstracts* is conscious of their great responsibility in maintaining an abstracting service available to all biologists, and it has been a matter of great concern that the cost has been so high that the benefits of this service have been largely lost to those who feel that they can not afford to subscribe. Unfortunately the editorial costs of preparing such a service are great, and it is apparent that the only possibility of decreasing the cost to the individual lies in securing a great increase in subscriptions.

For a long time it has been felt that some plan should be formulated that would more actively stimulate the interest and support of members of the several biological societies. In the hope that this plan will provide a greater service to biologists generally the trustees have approved the following: A reduction of $1.00 in the subscription price to any section, or sections, of *Biological Abstracts* will be granted the membership of any society *provided* that:

(1) They receive subscription pledges from at least 30 per cent. of their membership.

(2) It is understood that section subscriptions will be non-duplicating, *i.e.,* in cases where individuals are members of several societies, they will have the right to designate the society to which their section subscriptions will be credited.

(3) It is also understood that, in the case of an individual subscribing to *more than one section*, he may designate the appropriate societies to which each section subscription will be credited.

It is further understood that this plan does not supersede existing plans for support, such as direct subsidy of $2.00 a member by the American Society of Zoologists, but that it may be supplementary to such plans. As a further aid to individual biologists the costs of sectional subscriptions have been reduced in some cases.

It is hoped that many societies will take advantage of the opportunity to render this greater service to their membership. It is requested that a committee of interested members be appointed by each biological society to handle the matter. Further information on this plan, or a sample copy of a section, may be secured by addressing the Business Manager, *Biological Abstracts*, University of Pennsylvania, Philadelphia.

THE ANNUAL MEETING OF THE COUNCIL OF THE UNION OF AMERICAN BIOLOGICAL SOCIETIES

THE annual meeting of the Council of the Union of American Biological Societies will be held in the Colonial Room of the Neil House, Columbus, at 4:00 P.M. on the afternoon of Thursday, December 28, 1939. It is hoped that all representatives to the council will make a special effort to attend this meeting, since matters of more than ordinary interest will come up for consideration.

There will be a brief report by the editor-in-chief of *Biological Abstracts*, Dr. John E. Flynn. This will include a summary of the financial situation, the effect of the war and plans for Volume 14 (1940).

Dr. Riddle, as chairman of the Union's Committee on Biological Science Teaching, reports that the committee has continued its efforts to enroll greater numbers of high-school teachers in the National Association of Biology Teachers, which this committee sponsored and founded last year. In various ways individual members of the committee, as well as Dr. D. V. Miller, committee representative, have supported the new journal—*The American Biology Teacher*. Professor E. W. Sinnott became a member of this committee in July of this year, other members being Drs. E. V. Cowdry, F. L. Fitzpatrick, H. B. Glass and B. C. Gruenberg. During recent months the committee has given much care to the preparation of a questionnaire dealing with conditions affecting the teaching of biology in our secondary schools. This questionnaire was mailed in late November and early December to nearly 15,000 high-school teachers in 48 states. The results of this inquiry will guide and determine the committee's future efforts. The work of this year, like that of 1938, was financed through funds made available by the Carnegie Foundation for the Advancement of Teaching.

It is also planned to consider an amendment to the constitution of the union which will make possible a second type of membership, namely, "individual membership." It is hoped that the representatives of the various member societies will be prepared to consider this matter carefully.

GEORGE W. HUNTER, III,
Secretary

AWARD OF THE PENROSE MEDAL OF THE GEOLOGICAL SOCIETY OF AMERICA

PROFESSOR WILLIAM BERRYMAN SCOTT, of Princeton University, has been named by the Council of The Geological Society of America as the Penrose Medalist for 1939. The gold medal will be presented on December 29 at the fifty-second annual meeting of the society at Minneapolis.

The Penrose Medal was established in 1927 for the Geological Society by the late Dr. R. A. F. Penrose, to be awarded, under the terms of the deed of gift, "in recognition of eminent research in pure geology" and "of outstanding original contribution or achievements which mark a decided advance in the science of geology."

Professor Scott is the eleventh geologist to receive this medal. Born in Cincinnati, Ohio, in 1855 and now retired from active teaching, he was for fifty years Blair professor of geology and vertebrate paleontology at Princeton University. In the words of the Committee on Penrose Medal Award of the Geological Society,

> he is generally regarded as the leading American student of the Tertiary mammal faunas of the western hemisphere, with particular reference to their historical development and migrations. A familiarity with these problems led him also to a fruitful study of the principles of evolution. His many years of exploration of the Tertiary deposits in western United States and collaboration with Hatcher and others in Patagonia have resulted in more than fifty monographs as well as several comprehensive books. His wide range of interests is also indicated by his authorship of an excellent general text-book of geology.
>
> The importance and quality of his scientific attainments have been recognized by the award of honorary degrees from the Universities of Pennsylvania, Harvard, Oxford and Princeton, by medals from the Geographical Society of Philadelphia, the Geological Society of London, the National Academy of Sciences, the Academy of Natural Sciences, and by his election to the presidencies of the Paleontological Society, the American Philosophical Society and the Geological Society of America.

In nominating Professor Scott as Penrose Medalist for 1939 the committee on the Penrose Medal Award stated that "The award of the Penrose Medal to Pro-

Professor Scott at this time is recommended because of the distinguished place he has won for himself in the science of paleontology and its related fields of organic evolution and historical geology." The committee included Professors Eliot Blackwelder, Stanford University, *chairman;* E. L. Bruce, Queen's University, Kingston, Ontario; John P. Buwalda, California Institute of Technology; James Gilluly, University of California at Los Angeles; Adolph Knopf, Yale University; Donald H. McLaughlin, Harvard University, and Dr. W. P. Woodring, United States Geological Survey.

Previous recipients of the Penrose Medal are: 1927, Professor Thomas Chrowder Chamberlin, University of Chicago; 1928, Dr. Jakob Johannes Sederholm, director of the Geological Survey of Finland; 1930, Professor François Alfred Antoine Lacroix, director of the Mineralogical Laboratory of the Museum of Natural History of Paris; 1931, Professor William Morris Davis, Harvard University; 1932, Dr. Edward Oscar Ulrich, United States Geological Survey; 1933, Professor Waldemar Lindgren, the Massachusetts Institute of Technology; 1934, Professor Charles Schuchert, Yale University; 1935, Professor Reginald Aldworth Daly, Harvard University; 1936, Dr. Arthur Philemon Coleman, University of Toronto, and 1938, Professor Andrew Cowper Lawson, University of California.

SCIENTIFIC NOTES AND NEWS

THE Hughes Medal of the Royal Society, London, has been awarded to Dr. G. P. Thomson, professor of physics at the Imperial College of Science, London, for his "important discoveries in connection with the diffraction of electrons by matter." Professor Thomson is the son of Sir J. J. Thomson.

THE Sigma Xi lecture at the Columbus meeting of the American Association for the Advancement of Science will be given by Dr. Kirtley F. Mather, professor of geology at Harvard University, on Thursday, December 28. He will speak on "The Future of Man as an Inhabitant of the Earth." In honor of Dr. Mather, the society has arranged a dinner preceding the lecture. Dr. George A. Baitsell, president of the society, will preside.

IN honor of Robert J. Moore, development manager of the Varnish and Resin Division of the Bakelite Corporation, a dinner was given at a recent meeting of the American Institute of Chemists. The speakers were Dr. Marston T. Bogert, Dr. Robert Calvert, Dr. W. T. Read, Dr. F. D. Snell and Dr. Maximilian Toch.

DR. OLIVER E. BUCKLEY, executive vice-president of the Bell Telephone Laboratories, New York City, with which he has been associated since 1925, has been elected president to the Engineering Foundation to succeed the late Professor George E. Beggs. F. F. Colcord, vice-president of the United States Smelting Company, has been made vice-chairman of the foundation; Kenneth H. Condit has become chairman of the research procedure committee, and E. M. T. Ryder a member of that committee. Professor Walter I. Slichter, of Columbia University, has been elected a member of the executive committee.

DR. W. H. PIERRE, head of the department of agronomy at the Iowa State College, was elected president of the Soil Science Society of America at the New Orleans meeting. During the past year he was secretary of the society.

OFFICERS for 1940 of the Mineralogical Society, London, have been elected as follows: *President,* Arthur Russell; *Vice-presidents,* Professor C. E. Tilley, Dr. W. Campbell Smith; *Treasurer,* F. N. Ashcroft; *General Secretary,* Dr. G. F. Claringbull; *Foreign Secretary,* Sir Thomas H. Holland; *Editor of the Journal,* Dr. L. J. Spencer.

DR. HENRY W. HOLMES has retired as dean of the Harvard Graduate School of Education. He will continue his work as professor of education and has become chairman of the newly established University Committee on Educational Relations. Dr. Francis T. Spaulding succeeds him as dean of the school.

FREDERICK M. FEIKER, executive secretary of the American Engineering Council and a former director of the United States Bureau of Foreign and Domestic Commerce, has been named dean of the School of Engineering of the George Washington University.

D. W. MACCORQUODALE, formerly assistant professor of biochemistry at the School of Medicine of St. Louis University, has joined the research staff of the Abbott Laboratories, North Chicago, Ill., where he is in charge of hormone research.

RAYMOND P. SLOAN, vice-president of the Modern Hospital Publishing Company, Inc., associate editor of *Modern Hospital* and managing editor of *The Nation's Schools,* has been elected a member of the Board of Trustees of the Long Island College of Medicine.

DR. WILLIAM F. TALBOT, who in June joined the staff of Arthur D. Little, Inc., chemists and engineers of Cambridge, Mass., for the purpose of carrying out studies for the General Printing Ink Corporation, has recently been made research director of this company.

PROFESSOR EDWARD L. MORELAND, dean of engineering at the Massachusetts Institute of Technology, a member of the engineering firm of Jackson and Moreland, has been elected a member of the corporation of the Babson Institute, Wellesley Hills, Mass.

DR. DONALD WYMAN, of the Arnold Arboretum, Harvard University, has been appointed chairman of the newly constituted committee on arboretums and botanic gardens of the American Institute of Park Executives.

DR. C. MONTAGUE COOKE, JR., of the Bishop Museum, Honolulu, was made chairman of the standing committee on the distribution of terrestrial faunas in the inner Pacific of the Pacific Science Congress, which was held in San Francisco last summer.

DR. COLIN BARNARD, of the Council for Scientific and Industrial Research, Canberra, has been appointed local honorary secretary for the Australian and New Zealand Association for the Advancement of Science in the Australian Capital Territory, to fill the vacancy caused by the resignation of Professor G. A. Currie.

A COMMITTEE of members of the faculty of the School of Medicine of Yale University has been appointed to make a survey of the plan of instruction of the school in the light of the primary educational objective of giving broad training to qualified men and women for medical work. Members of the committee are as follows: Dr. Hebbel E. Hoff, associate professor of physiology, *chairman;* Drs. Warren T. Brown, assistant professor of psychiatry and mental hygiene; Philip B. Cowles, assistant professor of immunology; Daniel C. Darrow, associate professor of pediatrics; Alfred Gilman, assistant professor of pharmacology and toxicology; John C. Leonard, instructor in medicine; Gustaf E. Lindskog, assistant professor of surgery; Leon S. Stone, associate professor of anatomy; Herbert Thoms, associate professor of obstetrics and gynecology; John H. Watkins, assistant professor of public health; Abraham White, assistant professor of physiological chemistry; Harry M. Zimmerman, associate professor of pathology, and Dean Bayne-Jones, *ex officio.*

GRANTS recommended by the National Advisory Cancer Council, of which Professor Ludvig Hektoen is executive director, at its meeting on December 4 include Dr. Albert Tannenbaum, Michael Reese Tumor Clinic, Chicago, $3,600, for work on factors in the initiation of induced and spontaneous tumors; Dr. Wm. Ray Bryan, Duke University, $1,000, toward work on the papilloma virus protein and related material; Dr. Herbert M. Evans, University of California, $1,800, for study of nature and amount of urinary gonadotropic hormone coincident with various testicular neoplasms; Dr. Mont R. Reid, University of Cincinnati, $2,400, toward the improvement of present methods of diagnosis and treatment of cancer, and National Research Council, Washington, D. C., $3,000, in support of the American Registry of Pathology.

DR. ROBERT A. MILLIKAN, chairman of the Executive Council of the California Institute of Technology, who is engaged in a study of cosmic rays on a trip around the world, was in India when last heard from. He will continue his trip to Egypt and plans to return to the United States in February.

KARL P. SCHMIDT, a member of the Magellanic Expedition of the Field Museum of Natural History, has returned to Chicago and to his work as curator of amphibians and reptiles. Other members of the expedition, the leader, Dr. Wilfred H. Osgood, chief curator of zoology; Colin C. Sanborn, curator of mammals, and John Schmidt, assistant, will remain in the field for at least four months more. At present they are collecting in Chile, and soon will move on to the extreme southern tip of South America, along the Straits of Magellan, and to the island of Tierra del Fuego, where they will continue the research begun in 1834 by Charles Darwin on the cruise of the *Beagle*. Mr. Schmidt brought back approximately 500 specimens of mammals, 250 birds, 1,200 reptiles and amphibians, 400 fishes and a number of insects and invertebrates. The great majority are of species entirely new to the collections of Field Museum, and therefore of great importance to zoological research.

D. F. HEWETT, of the U. S. Geological Survey, has returned after ten weeks' absence in the West, where he visited most of the mining districts in which geologists of the survey are engaged in studies of strategic mineral deposits. He also conferred with numerous cooperating state officials. J. T. Pardee returned at the close of the field season, during which he supervised an examination of manganese deposits at Philipsburg, Mont., as a part of the strategic minerals program, and examined a dam site on Carbon River, near Tacoma, Wash., for the Water Resources Branch of the Geological Survey. H. E. Gregory spent about three weeks in the Washington offices of the Survey completing his report on the geology of the Zion National Park. He has returned to Honolulu.

DR. KARL F. MEYER, professor of bacteriology at the University of California and director of the Hooper Foundation for Medical Research, will deliver on December 21 the third Harvey Society Lecture of the current series at the New York Academy of Medicine. He will speak on "The Host-Parasite Relationship, with Particular Reference to Heterogeneous Infection Chains."

DR. M. L. CROSSLEY, director of research of the Calco Chemical Company, Bound Brook, N. J., re-

cently gave an address on "The Sulfanilamides as Chemotherapeutic Agents" before the New York Section of the American Chemical Society at the Chemists' Club. Professor Louis P. Hammett, of Columbia University, chairman of the section, presided at the meeting, which was preceded by a dinner at the club.

THE annual Huxley Memorial Lecture of the Royal Anthropological Institute, London, was delivered on November 28 by Dr. R. R. Marett, rector of Exeter College, Oxford. The title of the lecture was "Charity and the Struggle for Existence."

DR. EARNEST A. HOOTON, of Harvard University, gave an illustrated lecture, entitled "Anthropology and the Belligerents," on December 11 and 12 at the Smith College Club at Cambridge.

DR. PHILIP FOX, director of the Museum of Science and Industry of Chicago, was one of the speakers at a conference on vocational problems held at Northwestern University on December 6.

PROFESSOR DONALD E. CUMMINGS, of the University of Colorado School of Medicine, was the guest speaker at a meeting on November 25 of the Colorado Alpha chapter of Alpha Epsilon Delta, the national honorary pre-medical fraternity. The subject of his address was "Silicosis." Dr. C. E. Burford, head of the department of urology in the St. Louis University Medical School and president-elect of the Missouri Medical Association, was the guest speaker at the annual initiatory banquet of the Missouri chapter. His subject was "Some Shallow Excursions into the Fringes of Medicine."

THE seventh annual meeting of the American Science Teachers Association will be held on December 27 and 28 in conjunction with the American Association for the Advancement of Science under the presidency of W. L. Eckenberry, of the New Jersey State Teachers College at Trenton. On Wednesday morning, Thomas Midgley, Jr., Worthington, Ohio, chairman of the Board of Directors of the American Chemical Society, will make an address on synthetic rubber, in connection with which there will be an exhibit by the du Pont Company and an address on the anti-scorbutic vitamins by Dr. Charles Glen King, professor of chemistry at the University of Pittsburgh. "A History of Science in Mural Painting," by Elmer E. Taflinger, will be presented and briefly explained by Robert Lovell Black, instructor of biology at the Emmerich Manual Training High School, Indianapolis. At the luncheon meeting on Thursday Dr. Walter B. Cannon, president of the association, will make an address entitled "The Rôle of Chance in Discovery."

THE Geological Society of Philadelphia will hold one meeting each year at which a symposium will be presented on a major problem in the science of geology. Authorities on the subject will be invited to present their views, and other speakers will be welcomed. One problem, preferably of a controversial nature, will be fully considered. The subject of the first symposium will be the origin of anorthosites of the Adirondack type. Professor Robert Balk, of Holyoke College, and Professor A. F. Buddington, of Princeton University will speak on the Adirondack anorthosite. Katharine Fowler-Billings will discuss the Laramie (Wyoming) anorthosite and Dr. T. F. W. Barth, authority on certain Norwegian anorthosites, will take part. The opening session will be held at the Academy of Natural Sciences in Philadelphia at 8 P.M. on December 21, and the meetings will be continued next morning at Bryn Mawr College. Officers of the society are H. H. Hess, *president;* E. H. Watson, *past-president,* and A. E. Meier, Swarthmore College, *secretary.*

THE American Society of Tropical Medicine held its thirty-fifth annual meeting in Memphis, Tenn., from November 21 to 24. Special features of the meeting included the fourth Charles Franklin Craig lecture on tropical medicine, on "The Mechanism of Acquired Immunity to Metazoal Parasites," by Dr. W. H. Taliaferro, of the University of Chicago. The presentation of the Walter Reed Medal to Dr. William B. Castle, of Harvard University, was made by Dr. Richard P. Strong. Dr. Alfred C. Reed delivered his presidential address on "The Future of Tropical Medicine" at the annual luncheon of the society on November 23. On Thursday afternoon a joint session was held with the National Malaria Committee.

THE Geological Society of London announces that the eighteenth session of the International Geological Congress, which was to have been held in London from July 31 to August 8 next year, is indefinitely postponed. The London *Times* states that the invitation to hold the congress was accepted by the bureau of the seventeenth congress in Moscow, 1937, and was the outcome of a strong desire on the part of the fellows of the Geological Society of London and of British geologists in general to reciprocate the hospitality received by them on so many occasions in other countries, and to fulfil the wish that the congress, which last met in Great Britain in 1888, should meet there again. Sir William Bragg, president of the Royal Society, had been elected honorary president of the general organizing committee.

THE School of Mathematics of the Institute for Advanced Study each year allocates a small number of stipends to gifted young mathematicians and mathematical physicists to enable them to study and to do research work at Princeton. Candidates must have given evidence of ability in research comparable at least with that expected for the degree of doctor of

philosophy. Blanks for application may be obtained from the School of Mathematics of the institute, Fuld Hall, Princeton, N. J., and are returnable by February 15, 1940.

THE Rumford Committee owns a perfect diamond slab $9 \times 9 \times 3$ millimeters. The large surface and that at one end are flat to 0.1 wave-length of sodium light and are set at 90 degrees, the edge appearing perfectly sharp under a 300-fold magnification. The other surfaces are all rough cleaned. If any person would like to borrow this slab for experimental purposes, application should be made to the chairman of the committee, Norton A. Kent, the American Academy of Arts and Sciences, 28 Newbury Street, Boston, Massachusetts.

THE Galton Laboratory, of University College, London, is carrying on its work at the Rothamsted Experimental Station, Harpenden, Hertfordshire. It is announced in *Nature* that in view of the importance of chemical engineering at the present juncture, the Ramsay Laboratory of Chemical Engineering at University College, London, has reopened, and students will be accepted for training in chemical engineering and research.

AT the State Serum Institute, Copenhagen, Dr. Th. Madsen has established an International Salmonella Center, financed by the Commonwealth Fund. This laboratory supplies to Salmonella Centers in the various countries the sera and cultures necessary for serological diagnosis, *i.e.*, 50 sera and 100 cultures. So far, thirty-seven Salmonella Centers have been established. Those in the United States are: New York City, Dr. F. Schiff, Beth Israel Hospital; Albany, N. Y., Dr. A. Wadsworth, Department of Health, and Lexington, Ky., Dr. P. R. Edwards, department of animal pathology, University of Kentucky. The centers will receive and investigate doubtful cultures without charge.

DISCUSSION

GRASSLAND AS A SITE FOR BASIC RESEARCH ON TERRESTRIAL ANIMALS

THE greater part of a century has passed since Darwin published his famous work on the origin of species, and as yet no lands nor combined *natural* outdoor and laboratory facilities have been provided to study competition and the interchange of forces, which made up the basis of his theory. With the development of modern ecology and ecological processes, methods have come into use whereby studies of biotic interaction may profitably be carried on alone or in combination with laboratory studies. Various scientists have long hoped for lands and a laboratory where the interactions of land plants and animals and their physiological relations to climate can be studied just as the marine plants and animals are investigated in seaside biological stations. Pure science studies of terrestrial animals may well have much more intimate relations to human needs than marine inquiries. The sea has attracted the efforts of scientific men and the funds of granting bodies and philanthropists perhaps to an extent disproportionate to its human value. It has been demonstrated at the State University of Iowa that grassland grasshopper eggs may be used as a material for basic physico-chemical research, rivaling the sea urchin egg. The investigators at the University of Chicago have made use of striped ground squirrels taken from their native grassland haunts, for fundamental studies in hormones and for studies of the environmental factors that influence the important function of reproduction.

A grassland laboratory possesses facilities for research not available in some other types of land, such as forest or agricultural land. The great complication of forest vegetation makes many types of shelter and many niches affording protection from the elements to animals and smaller plants, which renders observations difficult. Tundra shares the advantages of grassland for researches involving field observations. These barren lands, however, are in a climate forbidding to continued scientific research and are remote from academic centers. Grassland, however, affords unrivaled opportunities for scientific biological study for the following reasons:

(1) Grassland allows full visibility of the more important larger animals and plants.

(2) Niches and hiding places for animals, such as tree tops, fallen and hollow trees and dense thickets do not occur in Great Plains areas to retard observation.

(3) The life histories and life span of the principal plants are about one tenth that of forest trees, and this greatly facilitates long-time observation because of the more rapid turnover and hence, the quicker response to climatic fluctuations.

(4) The grassland flora and fauna have intimate relations to the general problems of agriculture and human welfare on the Great Plains.

(5) Grassland constitutes about 40 per cent. of the original vegetation of the earth's land surface and is of great importance to mankind in general.

(6) It has been much less studied than forest.

(7) Stable primeval areas or semi-primeval areas of large size are rapidly disappearing. In another generation the program proposed by biological scientists may perhaps be impracticable.

(8) The field is unencumbered by organized pure science research projects.

(9) It is a vegetation type in which ecological interest is great and much important plant ecological work has been done on the moist eastern portion of the grassland, but all animal relations and their interactions with plants have been neglected.

(10) The problems of wind and water erosion of soil and the attendant dust movement are essentially biological problems.

(11) Suitable lands are of *low* economic value.

(12) Its climate is suitable for the work of investigators.

The plans of interested scientists have called for an undisturbed check area which could be under observation for a sufficiently long period to permit an analysis of drouths and dust storms, and rodent, predator and grasshopper outbreaks that occur separated by rather long intervals such as 30 to 50 years or more.

Agricultural lands are subject to such erratic overturn that causes of cyclic phenomena can not ordinarily be followed in a scientific manner. Game preserves and other small areas are, necessarily or unnecessarily, so managed as to obscure natural phenomena and render scientific conclusions unavailable or uncertain. Students of grasshopper outbreaks and, to a lesser extent, infestations of rodents desire large areas to follow the normal population of these pest animals. The need of a large area has been voiced by many, including grasshopper specialists, whose scientific results require freedom from *marginal effects* in this migratory group. For example, a tract of a few dozen sections of land surrounded by cultivated and overgrazed areas is so completely sprinkled with windborne organisms as to render conclusion as to natural trends uncertain.

The hope is that in the not too distant future scientific men can interest government agencies and granting bodies, which have helped with such projects in the past, to cooperate in providing land and facilities for basic terrestrial biological research. For example, an endowed laboratory could be set up on land of its own for the purpose of carrying on observations continuously. Such research would include analyzing the physiology of the animals in their relation to weather and climate, studies of competition, natural selection, reproduction, hormones, etc. For example, the National Park Service is interested in setting up a Great Plains National Monument large enough to prevent domestication of plains animals and to be managed on a hands-off basis. A laboratory adjacent to such an area would have many advantages.

V. E. SHELFORD

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OXYGEN REQUIREMENTS FOR GERMINATION OF SEEDS OF NYSSA AQUATICA—TUPELO GUM

IN the swamp forests of the southeastern United States frequently two species of trees are found to be dominants, *Nyssa aquatica* and *Taxodium distichum*. These trees have often been considered as very similar in their ecological requirements. Some time ago, 1932,[1] it was shown that *Taxodium* seeds can not be made to germinate under water, although after the seedling has attained a certain growth the roots and lower parts of the stem may be submerged indefinitely without harm. This is of interest ecologically, since it prevents the coming in of *Taxodium* in marshes that are continuously covered with water unless a dry season reduces the water to the point that the upper layers of soil become fairly dry.

So far as the writer has been able to learn, little has been known regarding the capability of seeds of *Nyssa aquatica* to germinate under water, although the trees may stand in water for indefinite periods.

The drupaceous fruits of *Nyssa aquatica* were collected in eastern North Carolina in September, 1938. They were allowed to dry and the fleshy exocarp and mesocarp tissue was removed, leaving the very hard endocarp enclosing the seed. On October 25 some of these "seeds" (endocarp plus seed) were placed in a metal cylinder containing sand, covered with water and placed out of doors at Raleigh, N. C. Similarly, a number of "seeds" were placed in a cylinder in moist sand out of doors at the same time.

On May 9, 1939, the cylinders were brought into the laboratory, and on the following day the sand containing the "seeds" was removed from the cylinders and placed in moist chambers kept in the laboratory. Those "seeds" kept moist but not flooded during the winter were kept in moist sand, and those that had been flooded were kept flooded under 3 to 4 cm of water.

When brought into the laboratory on May 9, three of the "seeds" from moist sand had already germinated. Subsequently, up to May 27 six additional "seeds" sprouted, giving a total germination in moist well-aerated sand of nine out of 21 "seeds." Up to the latter date none of the "seeds" kept flooded showed any signs of germination. Of 32 "seeds" kept flooded until May 27, sixteen were taken out on that date and placed in moist but well-aerated sand, the others kept flooded. From May 27 to June 16, eight of the "seeds" taken from the flooded container and given oxygen in moist sand germinated. None of the seeds kept flooded germinated up till the present, late July.

Since lack of aeration apparently prevents sprout-

[1] Delzie Demaree, *Ecology*, 13: 258–262, 1932.

ing of the "seeds" of *Nyssa aquatica,* it, like *Taxodium,* can not come in on an area kept constantly flooded.

IVAN V. SHUNK

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ON "A NEW COLOR REACTION FOR VITAMIN B_1 (THIAMIN, ANEURIN)"

VILLELA and Leal[1] report that pure synthetic Vitamin B_1 produces an intense blue color by the use of ammonium molybdate in sulfuric acid solution and aminonaphthosulfonic acid solution, and prescribe the quantitative method of Fiske and Subbarow, which is primarily used for phosphorus determinations.

The author was interested to ascertain if the blue color would be produced likewise when using stannous chloride as the reducing agent instead of aminonaphthosulfonic acid. Both reagents are used in phosphorus determinations by the blue color methods, and if thiamin interfered in one or both, it should be taken into account. Also since there is a distinct need for an efficient thiamin method, reports should be considered and evaluated.

By employing the stannous chloride reduction method,[2] it has now been found that thiamin (Vitamin B_1 Hydrochlor. Cryst. Merck) gives no blue color. Neither does thiamin give any blue by the Fiske and Subbarow method. Presumably, Villela and Leal[3] used thiamin chloride or hydrochloride, since no report of the isolation of the pure base has yet been made. However, by first treating thiamin chloride hydrochloride with NaOH (to produce the strong base),[4] neutralizing and immediately following with the procedure prescribed by Villela and Leal, no blue resulted. Reagents and procedure were, of course, thoroughly checked.

It is concluded that thiamin, or Vitamin B_1, does not give a blue color by the Fiske and Subbarow method nor by the stannous chloride reduction method. Thus thiamin does not interfere in phosphorus determinations. It is suggested that the blue color indicated by Villela and Leal was probably due to impurities.

GUY E. YOUNGBURG
UNIVERSITY OF BUFFALO MEDICAL SCHOOL

CHRONICA BOTANICA

COMMUNICATIONS from Dr. Fr. Verdoorn in November convey the information that the difficulties arising from the war situation in Europe which threatened the existence of *Chronica Botanica* have been solved.[1] It is announced that this important periodical will be published as a weekly beginning January, 1940, with the number of pages increased to 850 annually, with about 150 illustrations. Publications of all planned volumes of the "New Series of Plant Science Books," including numbers by Lloyd and Reed and H. I. Baldwin, together with the production of Volume 1, "Tree Growth" by MacDougal, will be carried out. The editor advises that urgent letters be sent by air mail and that all other mail be designated via "Holland America Line."

D. T. MACDOUGAL
F. E. LLOYD
H. S. REED

DECEMBER 5, 1939

SCIENTIFIC BOOKS

PHYSICS

Physical Science in Modern Life. By E. G. RICHARDSON. 256 pp. 16 plates. D. Van Nostrand Company, Inc. $3.00. The English Universities Press, Ltd. 8/6d.

THE publisher's blurb on the jacket is: "If you have wondered how an aeroplane flies—what constitutes a quicksand—why it is usually necessary to shake an embrocation, but not a mayonnaise—how a man can glide for four hours in an engineless aircraft—what limits clarity on a television screen and power in broadcasting stations—how a fish swims—whether we shall ever have trips to the moon—here is the book for you."

Certainly there can not be too many works that excite wonder or clarify the problems born in wonderment. The author claims to have set his back to the atom and the molecule and to have faced those recent advances which make contact with everyday existence. Perhaps his incentive came from his aunt, who was fond of lauding the advances in psychic science at the expense of those in the material world. When she asked him what physics had done for her, he replied that the tram had brought her up the hill that day. Thus he says the book might be called "tramway physics."

Perhaps beginning students and others do display glassy eyes when the conversationalist or lecturer begins by mentioning atoms, molecules, electrons, neu-

[1] Gilberto G. Villela and Aluiso M. Leal, SCIENCE, 90: 179, 1939.

[2] Guy E. Youngburg and Mamie V. Youngburg, *Jour. Lab. Clin. Med.,* 16: 158, 1930.

[3] It is to be noted that Villela and Leal use twice as much Molybdate II as Fiske and Subbarow. It made no difference, however, in this application.

[4] R. R. Williams, *Ind. Eng. Chem.,* 29: 980, 1937.

[1] Robert F. Griggs, SCIENCE, 90: 4418, November 3, 1939.

ns, cosmic rays, etc. Possibly it is wise to disarm 'aunties' by promising them that words or ideas t hurt or produce drowsiness will not be used. It is rtainly a worthy objective, to fill the great human d of understanding about the physical world with- using logic or ideas against which many people are ntally allergic. There are millions who love birds t know them only by sight, sound and habitat. It ms reasonable that millions should have a vibrant rtness for the discernment of natural phenomena mmensurate with the alertness of the man in the nd stand waiting for a home run.

Mechanics is covered in the chapter "Streams and ddies," with the idea that motion is a more attractive rting point than statics. No equations are given d the reader may not even discern that mathematics s necessary in the formulation of the knowledge. nerally the ideas are developed using the word "par- le" instead of "molecule," but in a few places he uses olecule" without apology.

In the subject of heat, molecules are mentioned, but seems to the reviewer it would have been better to ve recognized heat as molecular energy. It would ve been easier to explain the hot wire anemometer d the hot wire vacuum gauge. In this connection it uld have fitted the objective to have explained the rk streaks on the plastered ceiling of the usual farm use or the patches of dust collection on the plastered ll back of the radiators.

Physicists and mathematicians generally should read is book, partly to learn facts, but more especially to ppreciate how good an understanding of the subject n be given without using equations and formulae. he author's presentations and scope, with trifling ex- ptions, are sound. Recently an editor desired to rrect a writing to read that an ellipse was a flattened rcle. There is not an instance where the author has en guilty of describing an "ellipse as a flattened rcle."

Without decrying the need for physicists capable of per-mathematical analysis, one can not help feeling e need of more physicists who can reach out to the her men of common clay and thereby bring greater nefits to all. In general, such men will use formulae d complicated analysis for personal achievement ther than to dazzle and daze the audience.

F. C. BROWN

MUSEUM OF SCIENCE AND INDUSTRY,
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emonstration Experiments in Physics. By RICHARD MANLIFFE SUTTON. viii + 545 pp. New York: McGraw-Hill Book Company. 1938. $4.50.

THIS is a compilation of lecture demonstrations in ysics originated by the American Association of Physics Teachers, as suggested by Professor C. J. Lapp. Upon recommendation of a committee composed of Professors John Zeleny, C. T. Knipp and H. W. Farwell, the editor was appointed in 1935. More than 200 members of the association contributed.

The work is designated as a "cook-book" for teachers of physics to illustrate the principles of physics in a manner to develop a fascination and an understanding of the physical world about us. A "cook-book" is rarely read by others than cooks. The designation is rather modest, for this book should be used wherever there is need or latent desire to understand the simple elements of the physical world.

In general, the demonstrations are simple and require the minimum equipment for performance and are well designed to clarify fundamental principles rather than to daze the student or "show off" the instructor. There is, however, full recognition of the incentive for a student to think if he is amazed or intrigued. Thus brilliant brass trimmings are not specified, as garnishings may be recommended in a "cook-book." It is pointed out that every mathematical formulation of a principle can be translated into an experiment and that the skilful teacher will constantly resort to simple demonstrations to emphasize the relationships involved.

Most of the 1,200 demonstrations described are familiar to the experienced instructor. Nevertheless, every one will find unfamiliar and delightful new ones. For example, the "Falling Chimney—Free-Fall Paradox" was new to the reviewer. In this a ball is rested on the upper end of a meter bar, pivoted at an angle of 30°. A paper cup is attached to the meter bar 15 cm from the upper end of the bar. When the meter bar is released, the ball falls in the cup. This shows that the upper end of a pivoted bar travels faster than a freely falling body. This was recently shown to two most eminent teachers to whom it was new, both as to the principle and technique involved. Many demonstrations of this character are included. The reviewer would have welcomed two others in similar category—one is the free fall of a calling card, with edges turned up, in a stairwell. In this case the card falls with amazing steadiness perpendicular to direction of motion. The other is the "Robeval Enigma" involving the same explanation in balances as in M-41 (a).

The reviewer would praise this compilation of demonstrations by expressing the wish that two companion volumes might be published. One, "Automatic Demonstrations in Physics," would comprise descriptions with diagrams and illustrations that would be useful in the construction of equipment designed for students and others to operate, view and study without the necessity of an attendant instructor. Such demonstrations, like books in a library, would be available for study and pleasure at least forty hours a week instead of a meager ten minutes that might be possible

in a class period. The art of construction of such demonstrations is an extension of the automatic principles developed for manufacture and merchandizing.

The other desirable volume might be called "Showing off the Physical World." The demonstrations in this book should be designed for stage production for the fascination and education of the general public. In this connection one thinks of such performances as given by the Bell Telephone Laboratories, the General Electric Company, the Westinghouse Electric and Manufacturing Company and the General Motors Corporation.

F. C. BROWN

CHICAGO, ILLINOIS

REPORTS

GRANTS OF THE AMERICAN PHILOSOPHICAL SOCIETY

THE following grants in the natural and exact sciences were awarded by the committee on research of the American Philosophical Society in December, 1938, and in April, June and October, 1939. Grants in renewal of previous grants are not included, as these have already been published in SCIENCE.

Reginald D. Manwell, Syracuse University, for experimental animals in connection with the study of the exoerythrocyte cycle in avian malaria, and its relation to the development of immunity; the study to be centered about *Plasmodium circumflexum*. $300.

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James A. Shannon, New York University, for part payment for technical assistance in the study of the relationship between the renal tubular reabsorption of water and the role of the antidiuretic principle of the posterior pituitary; the effect of the composition of the body fluids upon the latter variable. $600.

Francis Owen Rice, Catholic University of America, for technical assistants in connection with his studies on the synthesis of polynuclear ring systems by a method of thermal polymerization. $1,000.

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Robert W. Pennak, University of Colorado, for apparatus to be used in making a study of the comparative limnology of north central Colorado. $350.

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ing expenses and equipment for the collection and preservation of folklore in West Virginia; folk-songs, folk-tales, legends, riddles, proverbs, superstitions, animal and plant lore, etc. $500.

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SPECIAL ARTICLES

PHOTOSYNTHESIS WITH RADIO-CARBON

ANTICIPATING the appearance of a complete report now in preparation, we wish to summarize very briefly the results obtained in the past year using unicellular green algae (*Chlorella pyrenoidosa*)[1] and radioactive carbon dioxide ($\overset{*}{C}O_2$). In some respects the $\overset{*}{C}O_2$ reduction is similar to that found in barley and sunflower plants previously reported.[2]

The rate of photosynthesis was measured simultaneously by the Warburg manometer method and the radioactive technique. The two methods agreed within the experimental error. The $\overset{*}{C}O_2$ reduction was found to be markedly affected by such poisons as hydrogen cyanide and phenyl urethane. The light and dark reduction was enormously decreased by 10^{-2}–10^{-3} M. HCN. It was observed, manometrically,[3] that at these concentrations of HCN photosynthesis was strongly inhibited, whereas respiration remained unchanged. We feel certain, therefore, that the radioactive indicator method as applied to *Chlorella* is not complicated by possible reversible steps in the respiratory process.

As in the case of the higher plants,[4] *Chlorella* cells reduce $\overset{*}{C}O_2$ in the dark. We have found this to be a reversible reaction; 85 to 95 per cent. of the *dark* reduced radioactive carbon could be extracted by boiling approximately one minute with water; 70 to 80 per cent. of the C* in this extract was precipitated[5] by barium or lead ion in 80 per cent. ethanol. The barium precipitate from the *light* reduction extract contains a smaller fraction of the C*. Prolonged boiling with 1 N. HCl did not decrease the barium-insoluble radio activity. These and other experiments indicate the presence of a carboxyl group in the radioactive molecule(s). Decarboxylation (dry distillation of barium salts) carried out on the dark water soluble material showed that most, if not all, of the labeled carbon was in the carboxyl group. To a far lesser extent this was also true of the light extract. A considerable number of naturally occurring carboxylic acids (*i.e.*, formic, acetic, propionic, oxalic, tartaric, malic, maleic, fumaric, citric, succinic, ascorbic) have been found inactive. Water-soluble proteins as well as a large number of molecules (aldehydes, ketones, ketoacids, carbohydrates, hydrolyzable polysaccharides) containing a free carbonyl group were also inactive. Benzoylation experiments indicated the presence of at least one alcoholic hydroxyl group in the radioactive molecule(s).

Preliminary experiments with glass diffusion discs (method of Northrop and Anson[6]) yield values for the diffusion coefficient of the radioactive substance in the water-soluble extract from *Chlorella* exposed to $\overset{*}{C}O_2$ for short times in light or dark which suggest the molecular weight to be large. A lower limit may be set at 20,000 although all indications are that the molecular weight is considerably greater.[7] Precautions were taken to ensure the diffusion measurements were made with

[1] Sterile cultures were used. We are indebted to Dr. W. Arnold and Dr. H. A. Barker for much help and advice in this connection.

[2] S. Ruben, W. Z. Hassid, M. D. Kamen, *Jour. Am. Chem. Soc.*, 61: 661, 1939.

[3] O. Warburg, *Biochem. Zeits.*, 100: 230, 1919.

[4] E. D. McAlister, *Jour. Gen. Physiol.*, 22: 613, 1939, using a different method, has also found a dark uptake of CO_2 by wheat.

[5] A mixture of different carrier substances was added in all the chemical analyses.

[6] J. H. Northrop and M. L. Anson, *Jour. Gen. Physiol.* 12: 543, 1929.

[7] Lack of information about the shape of the molecule(s) prevents a reliable estimation of the molecular weight. Experiments with Professor McBain using the ultracentrifuge are in progress and it is hoped these will make an accurate molecular weight evaluation possible.

true, non-colloidal solution. Within the experimental accuracy, the molecular weight was independent of the extraction method employed as well as time of exposure to $C^{*}O_2$.

The reversible uptake of CO_2 in the dark may be written as follows:

$$\text{(I)} \qquad CO_2 + RH \rightleftarrows R\text{—}\overset{\overset{O}{\|}}{C}\text{—}OH.$$

The formation of carboxyl is a probable reaction energetically and structurally and is suggested by the presence of radioactivity in the carboxyl group. According to thermal data for similar reactions, this process may be exothermic by 1–2 K. cal. The experimental data accumulated thus far indicate ΔF can be unfavorable by 1–2 K. cal. Free energy values for a reaction such as I, involving large molecules, are not available, however. For small molecules, the free energy change is +5–10 K. cal. Conjugation in the "R" to the carboxyl group may furnish resonance energy to help the reaction. A more favorable free energy balance may be gained by the occurrence simultaneously of processes involving other molecules or taking place within R itself. This reaction is undoubtedly catalyzed by an enzyme system. Evidence bearing on the nature of RCOOH (at least after extraction) is its molecular weight of 3,000 or more, solubility in water, insolubility in ether, absence of free carbonyl groups, presence of alcoholic groups and absence of pigments (chlorophyll, etc.).

At present the dark reversible uptake of CO_2 may reasonably be considered a part of the photosynthetic process,[8] since (1) it is found to be similarly poisoned by HCN, (2) the molecular weight of R is the same as that of the photosynthetic products (whether ultimate or not) formed in the light. That CO_2 does not combine with chlorophyll but with some other substance present in the cell has been suggested by many workers.[9]

Since the net reaction for photosynthesis is

$$nh\nu + H_2O + CO_2 \rightarrow 1/x(C \cdot H_2O)_x + O_2$$

one may, without specifying the various steps[10] involved, represent the photochemical process by the following schematic equation:

$$\text{(II)} \qquad RCOOH + H_2O + nh\nu \rightarrow RCH_2OH + O_2.$$

The CO–O_2 balance in photosynthesis, together with the absence of carbonyl groups in the observed products, infers reduction to hydroxyl. The similarity between the molecular weights and other properties of the molecules in the light and dark reactions suggests strongly that R in I and II are identical. The energy required for II is about 110 K. cal per mole of CO_2 reduced.

We may add that formaldehyde formation, sometimes postulated, would require about 135 K. cal per mole. In addition the above picture avoids the necessity of polymerization steps. The RCH_2OH may add another CO_2 and repeat the cycle to build up long carbohydrate-like chains. Indeed, R itself may be such a chain. Processes in which carbohydrates are formed by interaction of accumulated reduction products, are of course, not excluded.

We wish to acknowledge our indebtedness to our many associates, and especially to Professors W. M. Latimer, W. F. Libby, W. C. Bray and T. D. Stewart, for their interest and many valuable discussions and suggestions. The continued cooperation of Professor E. O. Lawrence and his colleagues in the Radiation Laboratory has made this work possible. Our thanks are also due to the Rockefeller Foundation for financial support to the Radiation Laboratory.

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[8] We wish to thank Professor G. Mackinney and Dr. H. A. Barker for friendly criticism.

[9] R. Emerson, *Ergeb. Enzymforsch.*, 5: 305, 1936; H. Gaffron and K. Wohl, *Naturwissenschaften*, 24: 81, 103, 1936; K. V. Thimann, SCIENCE, 88: 50c, 1938.

[10] These may be part of a process involving either a photosynthetic unit (Emerson and Arnold, *Jour. Gen. Phys.*, 16: 191, 1932) or a sequence of reactions as suggested by Franck and Herzfeld, *Jour. Chem. Phys.*, 5: 231, 1937.

THE PREPARATION AND PURIFICATION OF BRUCELLA ANTISERUM[1]

THE constituent of *Brucella* cells responsible for the clinical manifestations of brucellosis in man and animals appears from our studies to be a toxic soluble fraction.[2] Its toxicity may be demonstrated by any route of parental injection.

Preliminary studies have shown that the toxic action of the soluble fraction for experimental animals can be neutralized *in vitro* before injection by the precipitating action of a specific antiserum or by injecting a sufficient amount of antiserum shortly before the toxic antigen.

In order to obtain an antiserum of high precipitin titer or neutralizing power, and as free as possible of non-specific substance for therapeutic application in certain forms of human brucellosis, several procedures were examined.

The serum used was obtained from the cow. The fresh untreated serum precipitated the antigenic frac-

[1] Journal Article No. 396 n.s. from the Michigan Agricultural Experiment Station. This study was supported by a grant from the Horace H. and Mary A. Rackham Fund.

[2] R. B. Pennell and I. F. Huddleson, *Technical Bulletin* 156, Michigan Agricultural Experiment Station, 1937.

tion up to a dilution of 1:32,000. When the serum was diluted progressively, and the dilution of the antigen kept constant, precipitation ceased above a 1:40 dilution.

The procedures examined for the concentration and purification of the antiserum were: (1) dissociation of specific precipitates; (2) precipitation of immune globulin by dilution of serum with distilled water; (3) precipitation of immune globulin with alcohol; (4) purification by the use of salts of heavy metals; (5) disaggregation of serum proteins by means of pepsin and removal of non-specific protein by heat coagulation; (6) dissociation of serum proteins by sodium-chloride.

A combination of procedures (4) and (5) was the only one that proved to be of any value. Procedure (5) used by us is a modification of the ones described by Parfentjev (2) and Pope (1), (2), (3).

An outline of the procedure found adaptable to the purification of *Brucella* antiserum from the cow is as follows: To 500 cc of fresh serum was added 446 cc of 0.5 per cent. $AlCl_3$. The precipitate was centrifuged out and the excess of $AlCl_3$ removed from the supernatant by neutralization. The volume of supernatant recovered was 700 cc. Following this step, purified pepsin (Difco) was added to the serum to a final concentration of 0.5 per cent., the pH adjusted to 4 with citric acid, and the mixture digested for 1 hour at 37° C. Following digestion, the mixture was adjusted to a pH of 5.5, heated for 30 minutes at 60° C., and then centrifuged to remove heat-coagulated protein. The supernatant was recovered and precipitated with $(NH_4)_2SO_4$ at half saturation. The precipitate formed was removed and dialyzed in a Cellophane casing under pressure against distilled water until free from $(NH_4)_2SO_4$. The volume of the dialysate was now 300 cc.

Methiolate was added as a preservative and sufficient sodium chloride added to make the final concentration 0.85 per cent. The purified serum was sterilized by passing through a Seitz filter.

Table I shows the precipitation valves of the serum at different steps in its preparation.

The results of one of several experiments which demonstrate the high neutralizing ability of the purified antiserum *in vivo* are illustrated in Table II. In order to obtain complete neutralization of the toxic antigen *in vivo,* it is necessary to inject the antiserum at least ten minutes before the antigen. If a toxic dose of the antigen is injected before the antiserum or the two are injected simultaneously, no neutralization is obtained.

In order to determine whether the purified antiserum had any therapeutic action on the course of certain forms of human brucellosis, five patients were given daily subcutaneous injections of the purified serum

TABLE I

	Maximum precipitation of antigen	Maximum precipitin titer
Untreated serum	1:32,000	1:40
After $AlCl_3$ treatment...	1:256,000	1:128
After pepsin treatment..	1:4,000,000	1:2048

TABLE II

NEUTRALIZING ACTION OF PURIFIED *Brucella* ANTISERUM ON *Brucella* ENDOANTIGEN *in vivo*

G. Pig No.	Amount of anti-serum cc	Amount of endo-antigen mg	Tempera-ture reaction	Result
1	1	10	Normal	Lived
2	0.5	"	"	"
3	0.1	"	"	"
4	0.05	"	"	"
5	0.01	"	"	"
6	0.005	"	"	"
7	0.0025	"	"	"
8	0.00125	"	"	"
9	0.000625	"	−5 degrees	Dead 6 hours
10	0.000312	"	Normal	Lived
11	0.000156	"	"	"
12	None	"	−5 degrees	Dead 6 hours
13	"	"	−5 degrees	"

All injections intradermally.
Antiserum given one hour before endoantigen.

in amounts varying from 0.1 cc to 5 cc. Two of the patients failed to respond to treatment with the antiserum. The temperatures of two returned to normal and remained so after two injections. The temperature of the remaining one returned to normal following one injection, but again became elevated after a lapse of seven days. Three more daily injections were then given following the rise in temperature. The temperature again returned to normal and remained so.

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SELENIUM AND DUCK SICKNESS

A PREVIOUS communication[1] indicated that low concentrations of selenium produced poisoning in ducks in which the syndrome was identical with that described as produced by *Clostridium botulinum* type C.[2] Since the original work it has been possible to secure field material which would indicate that selenium is an important factor in western duck sickness in the areas studied. These results appear sufficiently significant to warrant recording.

Analyses of the livers of ducks and shore birds found dying of duck sickness in the Great Bear Marsh area, Utah Lake and the Lake Front Project, fifteen miles northwest of Salt Lake City, showed definite traces of selenium. Black ducks and mallards collected in the vicinity of Pymatuning Swamp, Pennsylvania (a non-seleniferous area), exhibited negative tests when

[1] A. C. Twomey and S. J. Twomey, SCIENCE, 83: 470, 1936.

[2] U. S. Dept. Agr., *Bull.* 411, May, 1934.

treated in like manner. In the chemical analyses of these tissues, a modification of the Robinson, Williams, Dudley and Byer[3, 4] method of determining selenium was used. Blank tests were run on all reagents. (See Table 1.)

TABLE 1

LIVER ANALYSES

No.	Species	Dry wt. liver	Ppm selenium
A*1	American pintail	5.197 gms	7
2	" "	4.201	16
3	Common mallard	3.667	19
4	" "	6.776	16
5	" "	4.716	40
6	Green-winged teal	1.669	44
7	" "	1.426	52
8	" "	1.307	76
9	" "	2.311	43
10	White-faced glossy ibis	4.075	25
11	Avocet	2.971	25
B†1	American pintail	3.196	11
2	" "	3.268	18
3	" "	2.065	39
4	" "	3.358	24
5	" "	1.519	40
6	Common mallard	2.369	34
7	Green-winged teal	1.635	148
8	" "	1.629	49
9	" "	2.522	32
10	" "	1.300	92
11	Shoveller	3.105	19
12	American coot	2.434	49
C‡1	Green-winged teal	2.335	none
2	Redhead	5.065	none
3	American pintail	5.380	none
4	" "	4.635	none
5	Common mallard	6.015	10
6	Redhead	5.910	10
7	Common mallard (juv.)	4.545	10
D§1	Common mallard	6.737	none
2	" "	6.091	none
3	" "	12.477	none
4	" "	7.976	none
5	" "	6.537	none
6	Common black duck	7.326	none
7	" " "	8.626	none

*A Samples from Utah Lake (dead ducks).
†B Samples from Lake Front Project, 15 miles northwest of Salt Lake City (dead ducks).
‡C Samples from supposedly healthy birds collected on shooting grounds near Brigham, Utah, prior to an outbreak.
§D Samples from healthy birds obtained from Pymatuning Swamp area, Pennsylvania.

A marked decrease in the size and weight of livers was noted in the specimens obtained from waterfowl dying of the duck sickness. This supports the experimental finding that ducks, which were poisoned on low concentrations of selenium as sodium selenite (up to 18 ppm.), fed in the drinking water, showed a reduction in the size and weight of the livers. The experimental birds also showed all the symptoms of western duck sickness in successive stages. Higher concentrations of selenium produced death within ten to twenty-four hours, and the birds died without perceptible shrinkage of livers.

Vegetation, including *Potamogeton pectinatus, Salicornia rubra, Chara* and *Ruppia maritima,* taken from Willard Spur and Unit 3 of the Great Bear Marsh area on August 29, 1939, showed no evidence for the presence of selenium. Soil and water samples taken from the same places contained no selenium.

Although large numbers of birds die during major outbreaks of duck sickness, they represent but a small percentage of the actual birds present in the areas.

The waterfowl poisoned with selenium probably ingest it in either an organic or inorganic form from small, restricted areas.

These results would indicate that selenium is a factor in western duck sickness.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE METHOD FOR THE FILING OF MICROFILM RECORDS IN SHORT LENGTH STRIPS

RECENTLY L. R. Dice[1] described a simple method of filing microfilm records. For the past three years, we have employed a different method which we believe has advantages commending its description. We have found the method applicable to an industrial laboratory library, a school library and to private libraries.

Much attention has been given to the filing of 25-, 50- and 100-foot lengths of microfilm copies of documentary material. Little attention has been given to lengths of film of not over 3 feet, and often under 18 inches in length. As it is customary to photograph 16 pages of the ordinary magazine, journal or similar material on a 1-foot length of 35-millimeter film, it often happens, particularly in the fields of science, that an entire article can be copied on one foot or less of film. We have found it more convenient to use such copies in their short-strip form rather than splice them together into long film lengths.

The film strips are conveniently stored in an ordinary 10 × 12-inch filing cabinet drawer by making use of specially prepared filing cards of this size. These cards are prepared by taking a 10 × 12-inch piece of 1/16-inch cardboard and sewing onto one or both surfaces of the card layers of cloth, so that pockets are formed. A convenient type of card, which we have employed extensively, consists of four pieces of cloth sewn on one side of the cardboard. This results in six rows of three pockets each or a total of eighteen pockets. Each pocket is capable of holding a one-foot film strip, or 16 pages; thus, on one card, it is possible to file 288 pages of microfilm copies of documentary material.

[1] SCIENCE, 89: 39–40, 1939.

[3] Robinson, *et al., Ind. Eng. Chem. Anal. Ed.,* 6: 274, 1934.

[4] *South Dakota Exp. Sta. Bull.,* No. 311, 1937.

We have used many different cloths in preparing these cards. If no attention is paid to the expense, a most excellent material is tracing cloth. However, we have found equally suitable and much cheaper ordinary book-binding fabrics. Another inexpensive material which we have used successfully is oiled silk. We have noted no injury to our films as a result of the use of the latter material. Any cloth which does not ravel along its cut edges and presents a smooth, non-scratching surface can be used. In sewing the cloth to the board, care must be taken that it is not pulled tight across the board but rather caused to cup slightly between rows of stitching to provide space for the insertion of the film strips. This may be accomplished by putting a small piece of cardboard, slightly greater in thickness than the film strips, underneath all the pieces of cloth when sewing the material to the cardboard. In order to have pockets accommodating 16 pages, the seams are run lengthwise of the card. In some cases, it is convenient to prepare cards to hold shorter strips, running the seams crosswise. It is also advantageous to indent each successive cloth layer one quarter of an inch further from the right-hand edge of the card than the cloth layer immediately beneath it. This affords easy access to the various pockets in a given row and reduces the number of pages which can be stored in the top pocket of a three-pocket card by only one page. Each pocket is 40 millimeters wide, thus giving ample clearance for the 35-millimeter film.

In filing the film, it is convenient to record the identifying data concerning the film and the source of the material which has been copied on a strip of gummed paper which can be pasted onto the cloth surface. There is ample room on the top surface of each row of pockets to record full information concerning each of the three films filed in the three pockets beneath. The films themselves may be given identifying numbers or notches on the leader of the film indicating pocket and card numbers, readily facilitating the return of the film to the card and pocket in which it belongs.

The use of such a system of cards makes possible the assembling of material pertaining to a given topic from widely divergent sources. On the other hand, we have used the cards as a means of assembling copies of several items from the same volume of a journal. The system is quite flexible and, as peculiar needs for variation in the filing scheme arise, can readily be adjusted to meet the immediate needs. For libraries, the issuance of an entire film card to the patrons can at least partially combat the drawback of the inability to scan shelf titles in a library of film, since the scanning of related titles on the card may serve to suggest further readings of interest.

Another use which we have made of these filing cards is to file copies of complete books and volumes of bound magazines in short strip lengths rather than in long reels. An advantage which we have found in this procedure is that, particularly in the case of reference works, it is more convenient to examine a short strip length containing the desired page rather than going through the majority of a 50- or 100-page reel to obtain a desired page reference. One other advantage of this scheme is that more than one person may make use of a book at the same time, provided that they wish to consult different pages. It is particularly convenient to file indices in this fashion.

The majority of books which are copied on microfilm do not exceed 550 pages. It will be noted that it is possible to file such a book on two cards prepared as described above to hold 288 pages each. However, if 18 pockets are prepared on each side of the cardboard, the entire book may be filed on one card. Probably most material on film lengths of 25 feet or more can best be filed in roll form. But it has been our experience in acquiring research material on microfilm during the last five years that a large majority of the items which we have required in connection with chemical research have been articles of 16 pages or less. Frequently the items do not exceed five pages.

We have found that this method of filing enables us to put a maximum number of films into a given space when short film lengths are involved. Thus it is possible to file, in a 28-inch filing drawer, 65,000 pages of material. If cloth is sewn on both sides of the cardboard and if more numerous pockets seem advisable, this number may be increased. Certainly such a system of filing makes possible the assembling of the research material required by individuals and small industrial research laboratories in an ordinary 4-drawer filing case.

A catalogue notation on 3×5-inch filing cards recording, in addition to the ordinary information found on library catalogue cards, the file card and pocket number in which the film is kept serves to locate the film. We have found an author and a journal listing of items received useful.

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BOOKS RECEIVED

BENNETT, H., Editor. *The Chemical Formulary.* Vol. IV. Pp. 638. Chemical Publishing Co. of N. Y. $6.00.

National Resources Committee. *Consumer Expenditures in the United States; Estimates for 1935–36.* Pp. iii + 195. Illustrated. Superintendent of Documents, Washington. $0.50.

SEDGWICK, W. T. and H. W. TYLER. *A Short History of Science.* Revised by H. W. TYLER and R. P. BIGELOW. Pp. xxi + 512. 61 figures. Macmillan. $3.75.

SOKOLNIKOFF, IVAN S. *Advanced Calculus.* Pp. v + 446. McGraw-Hill. $4.00.